Pre operative imaging prior to ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL): Can plain X-ray KUB, renal ultrasonography (RUS) and retrograde pyelography (RGP) be an equivalent alternative for intravenous urography (IVU)?

A dissertation done towards the partial fulfillment of the **Tamil Nadu Dr M.G.R Medical university M Ch Urology examination Branch IV examination on** August 2015

Bonafide certificate

This is to certify that the work presented in this dissertation titled" **Pre operative imaging prior to ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL): Can plain X-ray KUB, renal ultrasonography (RUS) and retrograde pyelography (RGP) be an equivalent alternative for intravenous urography (IVU)?**

done towards the partial fulfillment of the **Tamil Nadu Dr M.G.R Medical university M Ch Urology examination Branch IV examination on** August 2015 is the bonafide work of **Dr Gregory Pathrose, senior post graduate Registrar, Christian Medical College Vellore** done under my guidance and supervision**.** This dissertation has not been presented as a part or whole to any board or university.

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Abbreviations

CECT	Contrast enhanced computed tomography
X ray KUB	X ray Kidney ureter bladder
NCCT	Non contrast computed tomography
MRI	Magnetic resonance imaging
RUS	Renal ultrasonography
RGP	Retrograde pyelogram
PCNL	Percutaneous nephrolithotomy
URS	Ureterorenoscopy
IVU	Intravenous Urogram

ABSTRACT

Title

Pre operative imaging prior to ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL): Can plain X-ray KUB, renal ultrasonography (RUS) and retrograde pyelography (RGP) be an equivalent alternative for intravenous urography (IVU)?

Keywords: Intravenous Urogram (IVU), Renal ultrasonography(RUS), X ray Kidney ureter bladder(X-ray KUB), Retrograde pyelogram(RGP), Percutaneous nephrolithotomy(PCNL), Non contrast computed tomography(NCCT)

Aims and Objectives

With the availability of good resolution ultrasonography and retrograde pyelography (RGP), we sought to assess whether the treatment plan for percutaneous nephrolithotomy (PCNL) or Ureterorenoscopy (URS) will be altered without IVU or CECT

Material and methods

In this IRB approved, prospective observational study all eligible patients scheduled for URS or PCNL underwent RUS in addition to IVU prior to surgery. Post-operatively, two consultant urologists blinded to the treatment reviewed the RUS, X-ray KUB and RGP. After making the treatment plan, IVU and treatment offered were studied. Any change in plan attributable to IVU was documented. The agreement between index test and

reference test was given using Kappa statistics for categorical outcomes. The degree of assessment between the primary investigator and the consultants and also agreement with regards to renal function was calculated using Kappa statistics.

Results

Out of total sample size of 144, 95(65%) patients underwent PCNL and 50(35%) patients underwent URS. Out of the 144 patients, according to the principal investigators evaluation there was normal and abnormal ultrasound in 89(61%) and 55(39%) patients respectively. There was agreement between both consultants and the principal investigators evaluation with respect to involved renal unit involved (p=0.0).In 89 patients with normal RUS, there was change of plan only in 8(4%) patients who underwent change in the treatment suggested on the basis of X ray KUB RUS, RGP alone(table 8). In the remaining, 81(91%) patients the plan of treatment remained unchanged and the above 3 imaging tests were enough to suggest appropriate management.

Conclusion

URS and PCNL may be safe in radiopaque stones with normal renal architecture on RUS. Functional study may be beneficial in altered renal architecture.RGP and X-ray KUB provides a good pelvicalyceal anatomy to decide puncture for PCNL. Degree of parenchymal abnormality correlates well with drainage on IVU

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Pre operative imaging prior to ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL): Can plain X-ray KUB, renal ultrasonography (RUS) and retrograde pyelography (RGP) be an equivalent alternative for intravenous urography (IVU)?

INTRODUCTION

Urolithiasis is a common urological disorder, affecting patients across geographical, cultural and racial boundaries. The incidence of urinary stone disease has had a significant impact on the healthcare system due to the direct costs involved and the morbidity associated with complications such as infection and loss of function. Positive family history of stone disease, young age at onset, recurrent urinary tract infections, and underlying diseases like renal tubular acidosis (RTA) and hyperparathyroidism are the major risk factors for incidence and recurrence. High incidence and recurrence rate add enormous cost and loss of work days.

The management of renal calculi is mainly dependent on the symptoms and calculus size, which in turn relies on the accurate knowledge of calculus location and its spatial relationship within the collecting system. According to European Urological Association guidelines, shock wave lithotripsy (SWL) is the first line modality for stones < 20 mm for stones in the upper or middle pole or renal pelvis. Ureterorenoscopy (URS) had a higher stone free rate (SFR) for proximal mid and ureteral stones >10 mm. For stones > 20 mm, percutaneous nephrolithotomy (PCNL) is the optimal treatment strategy. Stones located in the lower pole can be treated by SWL, which has satisfactory results for stone sizes if calyceal anatomy has been found to be favorable on preoperative imaging. Calculus in the dependent calyces with narrow infundibuli cannot be treated with shock wave lithotripsy and hence PCNL is often the modality of choice to remove the stones. The mandatory information an urologist seeks prior to PCNL or ureterorenoscopy is the anatomy of the pelvicalyceal system which aids in nephroscopic and ureteroscopic navigation. Post operative imaging helps determine efficacy of the procedure used for clearance of stone and also subsequently need for secondary procedures in case of residual stones.

Commonly performed imaging modalities for delineating the pelvicalyceal anatomy and function prior to embarking on PCNL or URS include intravenous urography (IVU) or CT urography. With IVU or CT urography, additional information on the location of calculus in the renal collecting system can be studied prior to surgical management. In addition, the functional status of the kidney is also known from IVU or CT urography. Since its introduction in the early 1990s, unenhanced computed tomography (CT) has become the gold standard for the evaluation of urinary stone disease at many centers—in both the emergency department and the clinic—replacing radiography and excretory urography In our institution, a patient with normal renal function undergoes IVU prior to endoscopic surgery for stones.

With every CT or IVU, comes the disadvantage of radiation exposure, potential risk of intravenous contrast administration and in some canters additional waiting period for the investigation. In addition, CT or IVU also require bowel preparation prior to the test.

Though functional imaging helps in clinical decision-making, another important aspect to be considered is whether pure anatomical investigations can provide sufficient quantitative and qualitative anatomic information. All currently available pure anatomical studies have some limitations, though a combination of these may provide enough information needed for clinical decision making.

With the availability of improved machines for renal ultrasound (RUS), more information regarding anatomy of the pelvicalyceal system and renal parenchyma thickness can be obtained. In addition, the renal cortical echogenicity and renal parenchymal thickness gives some idea of the renal function. Additional anatomical information is obtained in all patients by performing a retrograde pyelogram (RGP), to delineate pelvicalyceal anatomy, which provides substantial information regarding location of the stone and degree of hydroureteronephrosis in most of the patients. If the required information is obtained by X-ray KUB and RGP, then the added risk of contrast risk and radiation may be avoided.

Currently percutaneous nephrolithotomy (PCNL) and ureterorenoscopy (URS) are the two mainstay procedures in the surgical management of renal and ureteric calculus respectively. Shock wave lithotripsy is used as a non invasive management of both renal and ureteric calculus PCNL involves initial placement of a ureteric catheter in the ureter under fluoroscopic guidance via a cystoscope. Contrast is injected via this catheter to delineate the pelvicalyceal system and plan access puncture. The tract is then dilated and a larger sheath is placed to allow passage of a rigid or flexible nephroscope into the collecting system. Working instruments may be passed through the nephroscope to facilitate fragmentation and removal of fragment PCNL is a procedure which is more invasive and morbid than SWL with higher likelihood of steroidal analgesia use, higher narcotic equivalents required for pain control, significant bleeding, and transfusion rates

Another treatment modality is the use retrograde ureteroscopy (i.e., passing a flexible ureteroscope from the bladder, up the ureter and into the renal collecting system) to fragment the renal calculi .Ureteroscopes are principally of two types rigid and semi rigid and the second variety being the flexible ureteroscope. The former is used in surgery for stones in mid and lower ureter while the flexible ureteroscope helps negotiate various calyces of the kidney. With sophisticated laser lithotripsy devices, most stones can be fragmented into tiny pieces (< 1 mm) and stone-free outcomes result in over 90% of cases of ureteral calculi after single procedure.

In this prospective study we wish to evaluate the role of IVU and the incremental benefit in patients undergoing URS or PCNL for management of stone disease. We will also identify, if there is a subgroup of patients who would benefit from IVU prior to intervention.

Types of stones

A. Calcium containing stones

1. Calcium oxalate monohydrate (70-80%)
2. Calcium oxalate dihydrate (40-60%)
3. Calcium phosphate (20-60%)
4. Calcium Hydrogen phosphate (2-4%)
5. Calcium Orthophosphate

B.Uric acid stone (5-10%)

C.Cystine stone (1%)

D. Mixed stone

1. Calcium oxalate phosphate (35-40%)
2. Uric acid-calcium phosphate (5%)

E. Struvite stone

Risk factors for stone disease

Genetic causes	Primary oxaluria, Cystinuria, RTA type II, Barters syndrome types III and IV
Anatomic abnormalities	Horseshoe kidney, Pelvi ureteric obstruction, Medullary sponge kidney, Polycystic kidneys
Epidemiological factors	Climate, Occupation, Dietary factors
Abnormal urinary PH	Gout, Infection stones
Excessive promoters of urinary crystallization	Idiopathic hypercalciuria, Enteric oxaluria, Hyperuricosuria
Reduced excretion of urinary inhibitors of crystallization	Hypocitraturia, Hypomagnesemia
Metabolic syndrome and Obesity	Pure Uric acid stones
Low urine volume	Reduced water intake or increased water loss
Lithogenic drugs	Triamterene, Indinavir Sulfadiazine
Inflammatory Bowel disorders	Crohn’s disease or Ulcerative colitis

Aim and Objectives

Primary:

To determine if preoperative X ray KUB, RUS and RGP alone would be sufficient instead of IVU in management of patients undergoing endoscopic surgery for radiopaque urinary tract stones.

Secondary:

To identify the subgroup of patients who would benefit from IVU based on X-ray KUB and RUS.

Review of literature

Imaging plays a major role in the diagnosis and management of patients with urolithiasis. The goal of imaging is to confirm the suspected clinical diagnosis, give detailed information about the stone and to provide guidance for therapeutic interventions.

In patients who have abnormal renal anatomy (e.g. horse-shoe kidney, ectopic kidneys, severe scoliosis or meningomyelocele) the relationship of the kidney to surrounding organs that are potentially in the line of percutaneous puncture may be atypical, and consequently cross-sectional imaging studies are needed to determine a safe line of access.

Non contrast CT

NCCT which is used as a rapid diagnostic test in the detection of urolithiasis provides information about size and location of the stones. In addition to these surrounding organs such as the pleura, colon, and liver[1-2] are clearly delineated. Unenhanced CT can exclude stone disease with a high negative predictive value (97%) and has the advantage of a short examination time[3]. When using a helical data acquisition, the entire examination can be performed in about 5 minutes of imaging time. In addition, because no oral or IV contrast material is used, the examination does not preclude or interfere with the subsequent performance of other imaging studies[4]. Rare anomalies like like retrorenal colon which is associated with colon is perforation during PCNL, may be diagnosed with NCCT

Disadvantages of NCCT

Even though NCCT is useful in planning a safe puncture, NCCT does not give enough information regarding the drainage of infundibulum and the function of the kidneys. Similarly, planning the route for the puncture is not as easy as with IVU. The radiation dose of a NCCT examination is approximately 3-5 rads when using a kVp of 120-140 and 200-300 mAs[4].

Multiplanar Computed tomography (MDCT)

Multiplanar reconstructions using 3D volume rendering may overcome these limitations and decrease the need for IVU for planning punctures. Multiplanar and three-dimensional evaluation of isotropic data sets[6], have enabled urologists better assessment of stone burden and undertake complex stone cases. Other than identification of the number, size, and location of calculi and determination of the presence of hydronephrosis (i.e., obstruction), multidetector CT also helps present information about volume, stone density, skin to stone distance and internal structure of the stone(homogenous or heterogeneous). High-resolution coronal reformatted images generated automatically from isotropic data sets obtained with 16–64-detector CT allow more rapid and accurate detection of urinary stones than do axial images alone and help planning and a predictor of treatment.

Dual Energy CT (DECT)

The improved new generation Dual Energy CT (DECT) devices improve imaging of urinary calculi with added advantage of using half the dose radiation. DECT provides the same anatomical information and gives far more detail about stone information. Jepperson et al. showed the ability of DECT to differentiate between small fragments adjacent to ureteral stents or nephrostomy tube[8]. Toebker[9] et al evaluated the split bolus CT protocol. They injected Iomeron® at 15 ml 10 minutes before and 80 ml 65 seconds before the scan. The protocol allows the combining of three phases (true and virtual non-contrast phases, and a contrast enhanced phase) and reconstructs transverse and coronal images. This technique provides the determination of stones 5 mm or larger with CT urogram images. Low dose CT significantly reduces the amount of radiation exposure and is the imaging modality of choice in acute stone evaluation and during follow-up in the urology clinic in patients with urolithiasis. Low dose CT can better assess urolithiasis and associated obstruction than plain abdominal radiographs

Intravenous Urogram (IVU)

IVU was developed in the 1920s and became the mainstay of upper tract imaging for most of the 20th century; it was the initial test in the evaluation of a variety of urinary tract complaints including abdominal pain, hematuria, UTIs hypertension or prostatism. IVU allows increased delineation of renal anatomy compared with the KUB and may reveal the presence of a calculus causing obstruction but it has a sensitivity and specificity of 85.2% and 90.4% respectively due to bone shadows and intestinal gas obstructing the stone shadows[10]. IVU is usually performed in supine position and the relation of the collecting system to the pleural space and ribs may change when the patient is prone. Nevertheless, the IVU can guide in selecting the appropriate calyx for percutaneous puncture based on the location of the stone, the infundibulopelvic angle, infundibular length and width and the spatial anatomy of the collecting system. IVU is also helpful in planning calyceal access to stone-bearing calyceal diverticula, as it delineates the calyx with which the diverticulum is draining and shows the size and position of the diverticulum.

Overall, IVU is a highly sensitive study, approaching 100% in some series where IVU is still performed. Literature describing series of authors with PCNL and URS have revealed that they do perform a functional study in form of IVU /CECT prior to stone surgery. But evidence supporting the role of functional imaging is scarce[11-12.]

Standard Procedure for Intravenous Urography

Patient is normally taken up for IVU after 2 days of bowel preparation with Tab Bisacodyl and Tab Digene.

Prior history of contrast allergy and bronchial asthma is excluded

Serum creatinine is checked for to rule out renal impairment.

1. The first film is a scout covering T12 to level of lesser trochanters. Scout is checked for adequacy and oblique films are taken.

2. Contrast is injected via an intravenous large bore cannula.

3. Nephrographic images (obtained 1–3 min after contrast material administration):

Nephrotomograms or images collimated to the kidneys.

Optional: oblique nephrographic images, oblique nephrotomograms, KUB radiograph

4. KUB radiograph (obtained 5 min after contrast material administration).

5. Abdominal compression (applied immediately after review of 5-min radiograph)

6. Pyelographic image collimated to the kidneys (5 min after compression, 10 min after contrast material administration).Optional: oblique images, repeat tomograms, early bladder filling images

7. Ureter-bladder images (obtained 15 min after contrast material administration and immediately after release of compression): KUB radiograph, fluoroscopic spot images of ureters. Optional: oblique KUB radiographs, prone images, upright images, delayed KUB radiograph.

8. Bladder image (bladder may be adequately seen on ureter images) Optional: delayed, oblique, prone or post void images.

Disadvantages of IVU

IVU requires an intravenous cannulation with a large bore cannula and injection of the contrast media, which can cause considerable discomfort. Patients are exposed to radiation with attendant risk. The risk of contrast reaction during IVU is between 5% and 10%[13] with a mortality rate of 0.01%.[14-15] IVU requires bowel preparation 2 days prior to procedure which results in further delay in definitive management and thereby causing increased renal loss due to stone burden. Recent studies suggest that many patients with urolithiasis may be subjected to relatively high doses of ionizing radiation during acute stone episodes and throughout the management of their disease due, in large part to need for repeated imaging during evaluation of colic and treatment of stones[16].

Magnetic resonance urography (MRU)

Magnetic resonance Urography (MRU) is an alternative to IVU with no ionizing radiation which is alternative to USG in pediatric and pregnant population.MRI uses a strong magnet, radio waves and computers to create detailed images of the body. More specifically, lying inside a massive hollow magnet, a patient is exposed to short bursts of powerful non-ionizing radio wave energy, directed at protons, the nuclei of hydrogen or water atoms, in the body. Radio signals generated by first "exciting" and then "relaxing" those protons, are computer-processed to form digital images, reflecting different types of tissue**.** Site of the obstruction may be seen clearly but the identification of the stone by signal void may be difficult. The accuracy of MRU in urinary stones when combined with tesla 2- weighted 3D series is 92.8% with sensitivity between 96.2-100% and specificity of 100%[17]. 3D MRI and 3D CT images with volume and surface rendering software provide an endoscopic view of the organs; the technique is known as virtual endoscopy. The main disadvantage of MRU is its limited availability and experience[18]

Also with the introduction of the Guy stone system[19], it was possible to predict the complexity of the PCNL, complications and stone free rate based on CT scan

I: Solitary stone in mid/lower pole with simple anatomy.

Solitary stone in pelvis with simple anatomy

II: Solitary stone in upper pole with simple anatomy.

Multiple stones in patient with simple anatomy.

Any solitary stone in patient with abnormal anatomy

III: Multiple stones in patient with abnormal anatomy

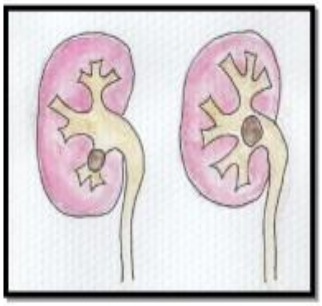
Stones in calyceal diverticulum Partial staghorn stones

IV: Staghorn calculus

Any stone in patient with spina bifida or spinal injury

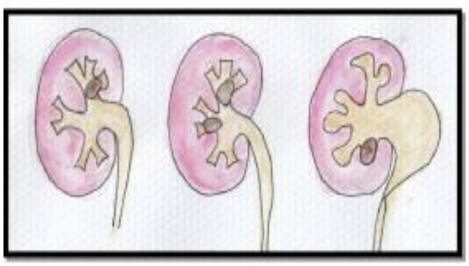
- Score based on all stones seen – not just those targeted in procedure.
- Abnormal anatomy is defined as: abnormal renal anatomy, an abnormal collecting system, or a patient with an ileal conduit (i.e. cases where operating surgeon believes access may be difficult).
- Stent encrustation does not affect score.

Grade I



A solitary stone in the mid/lower pole with simple anatomy
Or
A solitary stone in the pelvis with simple anatomy

Grade II

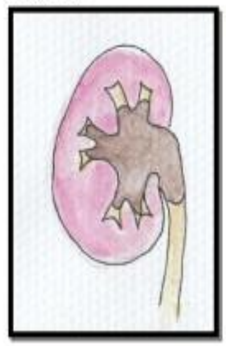


A solitary stone in the upper pole with simple anatomy
Or
Multiple stones in a patient with simple anatomy
Or
Any solitary stone in a patient with abnormal anatomy

Grade III

Multiple stones in a patient with abnormal anatomy
Or
Stones in a calyceal diverticulum
Or
Partial staghorn calculus

Grade IV



Staghorn calculus
Any stone in a patient with Spina Bifida or Spinal Injury

Alternatives to contrast enhanced imaging

In the present era of reducing the effect adverse effects of contrast media to the kidney and minimize radiation to the patient, can a single test or combination of various tests provide the same information as an IVU or CECT?

X ray kidney ureter and bladder (KUB)

X ray KUB which is sensitive in detection of stones as small as 4.2 mm and is routinely used in evaluation and follow up of stone disease.[20] The baseline radiograph demonstrates whether the stone is radiopaque and gives a good outline of the surrounding bony anatomy, phleboliths,other calcified structures and bowel against which further radiographs can be compared. X ray KUB is usually done at 75 to 80kVp and 20 to 25 mAs and is more sensitive than CT scouts in detecting ureteric and renal calculi and is readily available in many centers. The sensitivity of KUB in the detection of renal and ureteral calculi range from 58% to 62% and 67% to 69%, respectively[21-23]. Studies quoted by Chua et al[25] revealed the cut-off value at which urinary calculi not identified by CT Scout, but KUB radio graphically opaque is set at 630 HU with the overall sensitivity of 82.2% and specificity of 96.9% the lack of anatomic detail with regard to the kidney and surrounding organs limits its usefulness in preoperative planning for PCNL. KUB though not used as a sole imaging modality in urolithiasis is used in fluoroscopy guided shock wave lithotripsy and follow up of stones post urterorenoscopy and PCNL[24]. X ray KUB is used for follow up cases following shock wave lithotripsy and endourlogical procedures**.**

Renal Ultrasonography (RUS)

RUS is often the initial modality in evaluation of renal stones with particular advantage in pregnant, pediatric and patients with recurrent urolithiasis. Ultrasound is based on the interpretation of sound waves that have been reflected by the interface of different tissues in the body. The fundamental principles of ultrasound include the piezoelectric effect, pulse–echo principle, and acoustic impedance. RUS may detect calculi as small as 5 mm and is usually operator dependent as all stones show echogenicity and posterior shadowing. RUS can also reveal secondary effects, such as obstruction, superimposed infection, or abscess formation[26]. It has been postulated that elevated renal resistive indices on Doppler sonography may be a useful indicator of acute obstruction, but results have been varied[27]. To confirm the visualization of a calculus, color Doppler imaging can be used to elicit a twinkle artifact in the expected region of shadowing on gray-scale imaging. The Doppler Effect is the change in frequency or wavelength of transmitted sound waves that occurs when there is relative motion between the transducer (sound source) and reflecting surfaces (red blood cells). This shift in frequency between the received and transmitted frequencies is measured in Hertz (Hz). This change can be represented either visually by color or by an audible signal[28]. Pulsed duplex Doppler ultrasound allows for flow to be superimposed on the image as a continuous time–velocity waveform. Twinkle artifact[29] is thought to be due to narrow-band intrinsic machine noise. To observe twinkling artifacts, focal zones were always placed near the depth of the calculi with careful control of the B-mode gain settings. For color Doppler sonography, a red and-blue color map was used, and the color window size was adjusted to cover the concerned lesion and adjacent tissue. The presence of a color signal was assessed relative to adjacent soft tissue. Visualization of ureteral calculi requires the B-mode gain settings with dynamically control of focal zone, depth, and time-gain compensation curve. Also the newer generation ultrasound machines have a greater ability to pick up altered echogenicity of kidneys and presence of HUN.

Secondary signs of presence of stones in the ureter include hydronephrosis, a perirenal fluid collection, and a change in the resistive index of an interlobar artery

Disadvantages of RUS

One of the major drawbacks of RUS is the need for documentation of posterior acoustic shadowing to make a diagnosis of stone disease. This can be hampered due to presence intervening tissue with different acoustic impedance values or inappropriate transducer selection. RUS is a poor modality in detecting stones less than 4 mm which is of importance in recurrent stone formers from metabolic disease**.**

Newer modalities of Ultrasound: Three dimensional USG

The newly developed three-dimensional ultrasound reconstructions provide from a single sweep of the ultrasound probe that provides 36 degree viewing of the area scanned and reconstruction of image in any plane[30], including coronal, sagittal, or axial planes which eliminates the problem of user-dependent variation in scanning.Three-dimensional scanning also provides increased measuring accuracy, especially when looking at volumes, and allows for a better appreciation of the anatomic relationships between the area of interest and its surrounding structures.[31]

4D Ultrasonography

Taking the leap of development of ultrasonography was further enhanced with the introduction of incorporates a temporal dimension to three-dimensional ultrasound[33]. This approach is useful for performing volume assessments as a function of time in dynamic systems, such as the cardiac cycle and solid organ biopsy[34].

Harmonic Ultrasound

Harmonic imaging is sonographical procedure in which the higher harmonic echoes (usually the second harmonic) of the fundamental (first harmonic) transmitted frequency are selectively detected and used for imaging[28]. When harmonic B-mode imaging is used to improve image quality and contrast resolution of tissues, the technique is called tissue harmonic imaging. One of the main advantages of harmonic imaging is advanced near field resolution (closer to the transducer) and improved contrast resolution (the ability to observe subtle changes between adjacent tissues).[35]

Multi-dimensional imaging provides powerful and detailed spatial relationships that can be reviewed from any angle and readily compared over time. These modalities provide a comparable assessment of renal morphology when compared to CECT and IVU. The accuracy of KUB and USG combination versus non contrast helical computed tomography (NCCT) found the combination of KUB and USG highly sensitive (97.9%).[36]

Intraoperative imaging

Prior to introducing the ureteroscope or placing a ureteric catheter, retrograde pyelogram (RGP) is performed to delineate the pelvicalyceal system by injecting contrast the ureter using a ureteric catheter. Regardless of the imaging modality used to gain access, intra-operative fluoroscopy is indispensable for the successful completion of PCNL. The RGP provides a good ground for placing ureteric catheter for delineating calyces prior to puncture in PCNL and to obtain a roading prior to URS.

To facilitate fluoroscopic-guided percutaneous puncture, dilute contrast or air is instilled by means of a retrograde ureteral catheter placed cystoscopically at the time of PCNL. Opacification of the collecting system delineates and distends the collecting system, further facilitating access. The instillation of air to create an air pyelogram has an advantage over instilling contrast in that air can identify the posterior calyces and avoids obscuring the stone[37]. The location of the stone-bearing calyces and their relation to the overlying ribs allows the surgeon to target the appropriate calyx, taking into account the risk of pleural violation. Upper pole percutaneous puncture provides optimal access to large or complex renal calculi, to stones isolated in the upper pole calyces, to lower pole partial stag horn calculi, and to large ureteropelvic junction stones. Lower pole access is favored for a primarily lower pole stone burden or for renal pelvic stones. Mid pole access generally is reserved for direct puncture onto isolated mid pole stones, because access into these calyces may not allow inspection of either the upper or lower pole calyces.

Use of functional evaluation studies before deciding on the treatment modality has been considered safe and an orthodox practice and a standard teaching guideline for all patients of renal stone disease, though there is scarce evidence to support or denounce it. The origin of functional imaging dates back decades when stone removal was a major surgery and any decision that would cause the surgeon to regret his decision would be unwise. Also in the earlier years a single test that would give information about the renal anatomy and function were limited. Now it is well known that the functional information available from seeing contrast excretion on X-ray films is relative, crude and imprecise. Also in today's world of medico legal litigation, it would be safe to warn the patient if he was a marginally functioning kidney due to stone disease about his renal status prior to surgery.

However there is enough evidence in medical literature which suggests that anatomical parameters like renal parenchymal thickness, renal length, area or volume, etc., provide sufficient information[37] about the function of the renal unit and these are frequently considered as clinical surrogate markers of renal function. Radiation exposure should be minimized using newer techniques like low-dose protocols for CECT or IVU with digital tomosynthesis, etc and thereby preventing renal loss.

The key principle in maximizing safety is to keep the exposure as low as reasonably

Achievable (ALARA),to protect the patient and health care workers alike. Radiation exposure from imaging is measured in Gray (Gy) which defined as energy absorbed per unit mass (J/kg).But due to differential sensitivity of organs to radiation absorption, a term (mSv) is used which is the measure of effective dose and thereby cumulative harm to the patient.

Effective dose (in mSv) estimates the potential adverse biologic effect of the sum of the equivalent doses of radiation to exposed organs; therefore, radiation exposure from various types of diagnostic imaging studies can be compared in terms of relative biologic risk.

Also the potential of Ionizing radiation to harm through via deterministic and stochastic effects is well known in literature[38]. Deterministic effects (e.g., erythema of the skin and generation of cataracts) occur at a given threshold, and the effect is proportionate to the dose. Stochastic effects (e.g., the induction of secondary cancers or hereditary defects) are not dose dependent. The probability that a stochastic effect will occur increases with the dose, but not the severity of the effect[39]. Stochastic effects are currently believed to be low-threshold events linearly correlated with dose.

Table 1 .Authors and imaging preferences in Pre and post operative period

Authors	Series	Initial Imaging	Follow up
Ahmet Tefekli et al	PCNL	CECT/MDCT	RUS early post operative period. Later RUS /NCCT
Schilling et al	PCNL	IVU + RUS OR NCCT + RUS.	NCCT and RUS
Razvi et al	PCNL	NCCT Functional imaging only if ipsilateral kidney shows renal impairment like atrophic kidney or parenchymal thinning	NCCT
Aghamir et al	URS	RUS, X-ray KUB	RUS or X-ray KUB
Youssef et al	URS	NCCT	RUS or X ray KUB

We send questionnaires to authors who have published case series in PCNL and URS inquiring the modality they preferred prior to stone surgery and follow up. Tefekli[40] et al suggested they always did a CECT/MDCT in all pre operative cases while NCCT or RUC was used for follow up. Schilling[41] et al used a combination of IVU and RUS or NCCT or RUS. Razvi[42] et al used only NCCT and only investigated with CECT if there were parenchymal abnormality on NCCT. Both Aghamir[43] and Yossef[44] used RUS and X ray KUB and NCCT was done on day of surgery to look for expulsion of calculus.

RGP was done in all cases to delineate pelvicalyceal anatomy intraoperatively.

Relevance of study

In our centre, those with normal renal function, an IVU is done in prior to intervention to plan the approach and to assess function. The drawback of this functional study is adverse effects of radiation, contrast administration, time and cost. This study aims to compare functional assessment with alternative imaging including RUS, x ray KUB and RGP.

Also it has been well observed that urolithiasis has high recurrence rates. If we note that IVU can safely be avoided in case of stone recurrence, then other mentioned modalities can be used for follow up in cases.

Also multiple exposure to radiation and contrast may cause radiation injures to patients if used for follow up. We sent questionnaires to authors who published their series on

PCNL and ureteroscopy results and almost everyone did order a functional study prior to stone surgery .But Dr Hassan Razvi [42]whose paper titled “Percutaneous Nephrolithotomy: A single centre’s experience over 15 year in the Journal of endourology” only performed functional on patients who on pre operative NCCT revealed ipsilateral renal impairment such as thin parenchyma thinning or atrophic kidney

In this study we wish to evaluate whether the IVU prior to stone surgery is of any incremental benefit in addition to RUS, KUB and RGP. We also wish to study whether patient with normal renal function and adequate parenchymal thickness can safely undergo PCNL or URS on the basis of RUS, X ray KUB and RGP without IVU

Table 2. Imaging modalities and Radiation exposure

Imaging	**Radiation exposure {Effective Dose mSv (mrem)}**
X ray KUB	1.2 (120)
KUB with tomograms	3.9(390)
USG	0
NCCT	6-7(600-700)
Contrast CT	10.0 (1,000)
Intravenous pyelogram	2.5 (250)
MRI	0

Table 3: Imaging modality and their stone detection rate

Modality	Median Sensitivity	Median Specificity
Conventional radiography	57%	76%
Ultrasound	61%	97%
Intravenous pyelography	70%	95%
MRI	82%	98.3%
CT	98%	97%

Table 4.Overview of Imaging in Urolithiasis

Imaging Modality	**Advantage**	**Disadvantage**
X ray KUB	Information regarding opacity of stone	No information anatomy of pelvicalyceal or relation of stone to renal unit
Ultrasonography	Images the parenchymal and PCS and offers information about echogenicity	Operator dependent Poor information about ureteral anatomy
Retrograde pyelogram	Anatomy of the pelvicalyceal system delineated intra-operatively	Contrast injection Invasive modality
Non contrast CT	Fast and rapid diagnosis of urolithiasis	Expensive Radiation exposure
Intravenous urography	Commonly used based on contrast excretion	Contrast allergy Radiation exposure Need for bowel preparation
CECT urography with 3D reconstruction	Commonly used in developed nations. Provides information about PCS anatomy and functioning of kidney	Expensive Radiation exposure
MRI Urography with 3D reconstruction	Same as CT urography Can be used in patients with renal impairment Pregnancy	Expensive Allergy to Gandolinium Stone visualization poor

Table 5.Treatment option for urolithiasis

Treatment	Clinical Indications	Advantages	Disadvantages
Common			
SWL	Stones <1 cm in kidney or proximal-distal ureter	Least invasive procedure, good success rate, may be performed with patient sedated (although anesthetic is sometimes used)	Poor success rates for high-attenuation stones (>1000 HU) and cystine stones
Ureteroscopy with lithotripsy (semirigid)	Stones <1 cm in distal ureter, proximal ureteral stones in women	High stone-free rate (slightly higher than with SWL), allows visualization and extraction of stones, is used to treat stones refractory to SWL	More invasive than SWL, requires general or spinal-epidural anesthesia
Ureteroscopy with lithotripsy (flexible)	Stones <1 cm in proximal ureter, stones <1.5 cm in kidney	High stone-free rate (slightly higher than with SWL), allows visualization and extraction of stones	More invasive than SWL, requires general or spinal-epidural anesthesia
PCNL	Stones >1.5 cm in kidney or proximal ureter, stones >1 cm in lower pole of kidney, staghorn calculi	Highest stone-free rates for large renal and upper ureteral stones and lower pole renal stones	More invasive than SWL and ureteroscopy, may require blood transfusion (<5% of cases)
Uncommon			
Open or laparoscopic ureterolithotomy	Large stones in middle or distal ureter	More effective than SWL or ureteroscopy for removing very large stones	Rarely used because other modalities are effective for treating the majority of stones and are less invasive
Open or laparoscopic pyelolithotomy	Large unbranched renal pelvic stones, large stones in a horseshoe kidney	More effective than SWL or ureteroscopy for removing very large stones, may be preferred modality for large stones in a horseshoe kidney if percutaneous access is difficult	Rarely used because PCNL has excellent success rates; in large renal stones with branches (ie, staghorn calculi), PCNL may have higher stone-free rates
Anatrophic nephrolithotomy	Full staghorn calculi (ie, branching into most or all of the minor calices)	Reasonable alternative to PCNL that requires more than two percutaneous tracts	Rarely used because most renal stones can be treated with PCNL via one or two tracts

Materials and methods

This prospective observational study was conducted in the Department of Urology, Christian Medical College Vellore. All patients with ureteric and renal stones underwent additional RUS and X-ray KUB in addition to IVP. Appropriate surgery was carried out (PCNL or URS). All patients underwent an intra operative retrograde pyelogram which was stored. After surgery, two consultants blinded to the treatment carried studied the RUS, x ray and RGP images and an appropriate plan was made. They then studied the IVU. Any change in plan after studying the IVU was documented. Various surrogate markers of renal function such as parenchymal thickness of ipsilateral kidney, degree of hydroureteronephrosis, serum creatinine and contra-lateral kidney status were measured and documented

Also an objective assessment of the both the renal units of the patient were studied and on the basis of the above criteria.

Two consultant radiologists performed RUS. Sonography was performed with the patients in the supine position. An iU22 system with a C5-2 convex transducer (Philips Medical Systems, Bothell, WA) The X-ray KUB, USG RGU and IVU were reviewed by consultants urologists well versed with endourological management of stones.

Patients undergoing URS or PCNL will be reviewed post procedure to study complete stone clearance and their imaging modalities will be compared to evaluate the role of functional study. In patients undergoing URS, impaction versus non-impaction and need for stenting post procedure was documented.

In cases of patients undergoing PCNL, punctures were decided by two consultants. They were blinded to the puncture made exclusively on the basis of X ray KUB and RGP. Their decision was compared with the final puncture made by the operating surgeon to assess to find out whether a preoperative puncture choice was significantly influenced by IVU. Evaluation of the affected and contralateral kidney based upon the drainage of IVU was studied and were noted and compared with assessment with principal investigator. Stone free rates were documented for both procedures.

Inclusion criteria:

1. Patients with ureteric and renal stones planned for endoscopic surgery
2. Patients requiring IVU prior to procedure

Exclusion criteria

1. Contrast allergy.
2. Chronic kidney disease.
3. Failure to give consent.
4. Imaging completed prior to arrival
5. Acute pyelonephritis

Criteria used to classify RUS as “normal” by principal investigator

- Parenchymal thickness > 1cm
- Minimal pelvicalyceal separation < 1 cm
- Normal parenchymal echogenicity and architecture
- Renal length 9 -12 cm

On the basis of the RUS, a renal unit was classified as

- Normal (Presence of all four characteristics)
- Mild impairment (Presence of three characteristics)
- Gross impairment (Presence of two or less characteristics)

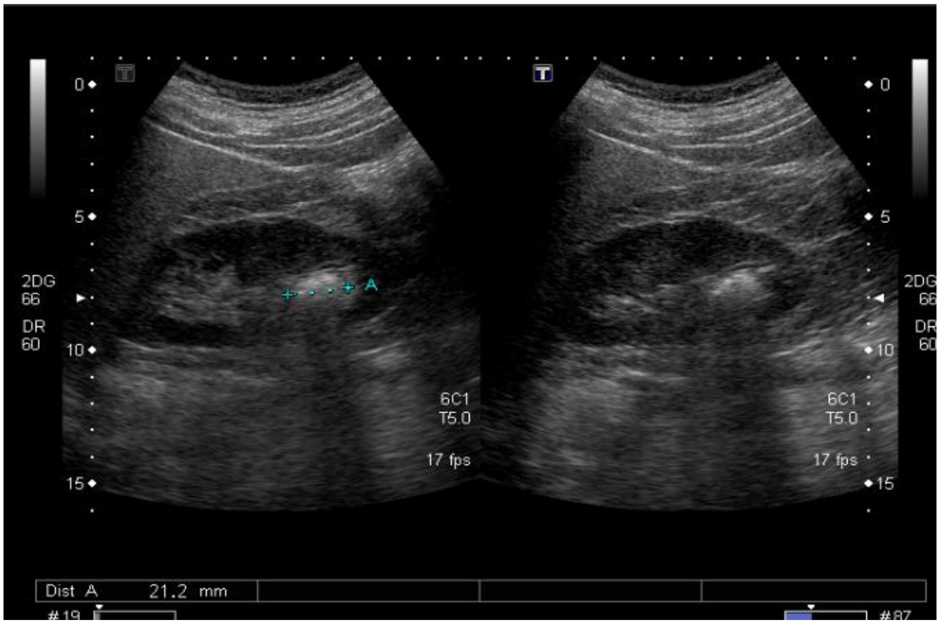


Fig 1**:** KUB film showing right calculus occupying the right lower pole infundibulocalyx

Evaluation of drainage on IVU

Grade 1 –Prompt drainage with no delay

Grade 2- one or two film delay with mild clubbing of calyces

Grade 3 – more than 2 film delay with prominent clubbing of calyces

Grading of HUN according to IVU

Fig 2 Grade 1 prompt excretion

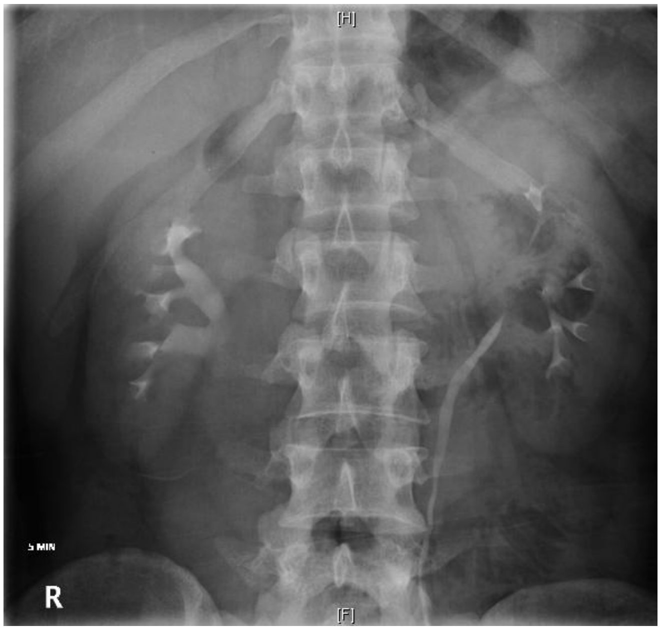


Fig 3 Grade 2 Mild delay 1 or 2 film delay

Fig 4 Grade 3:>2 film delay in excretion

Evaluation of Retrograde pyelogram for Ureterorenoscopy

1. Free proximal ureter opacification

2. Streak of contrast opacifying proximal PCS

3. Non-opacifying proximal PCS

Fig 5-well opacifying proximal system

Fig 6.Streak of contrast opacifying proximal PCS

Fig 7- non opacifying proximal system

Evaluation of Retrograde pyelogram for Percutaneous Nephrolithotomy

1. All Calyces well delineated, satisfactory for puncture

2. Calyces seen but not satisfactory for puncture

3. Proximal collecting system not visualized

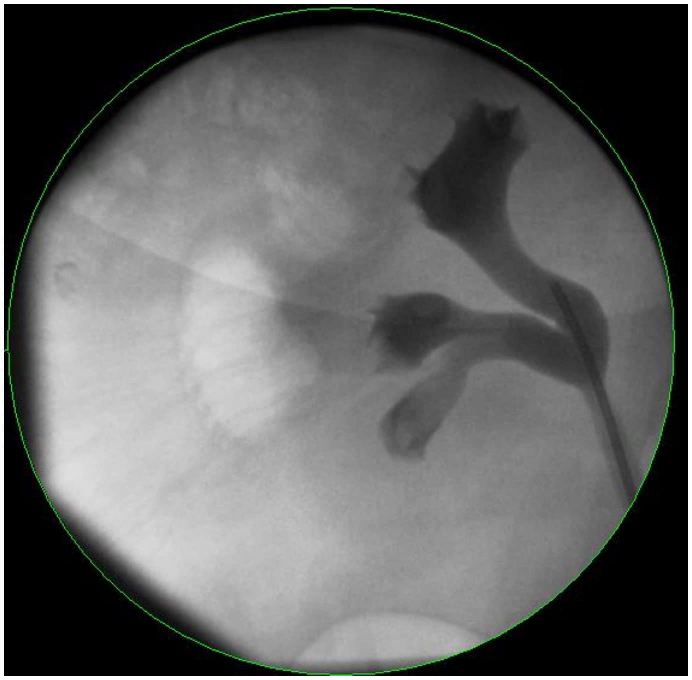


Fig 8- All calyces well delineated, satisfactory for puncture

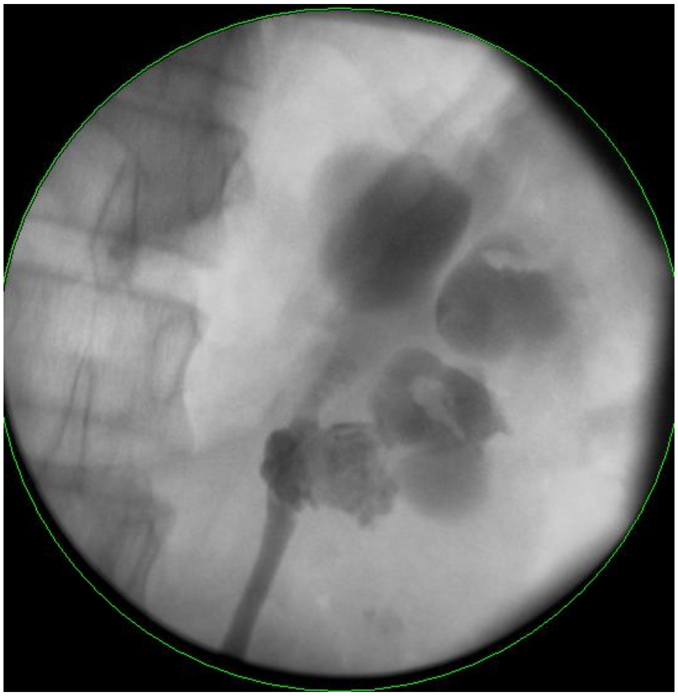


Fig 9: Calyces seen but not satisfactory for puncture

Fig 10- Proximal collecting system not visualized

Sample size calculation

Single Proportion - Absolute Precision

Expected Proportion = 10% (Prevalence of Ureteric Stone)

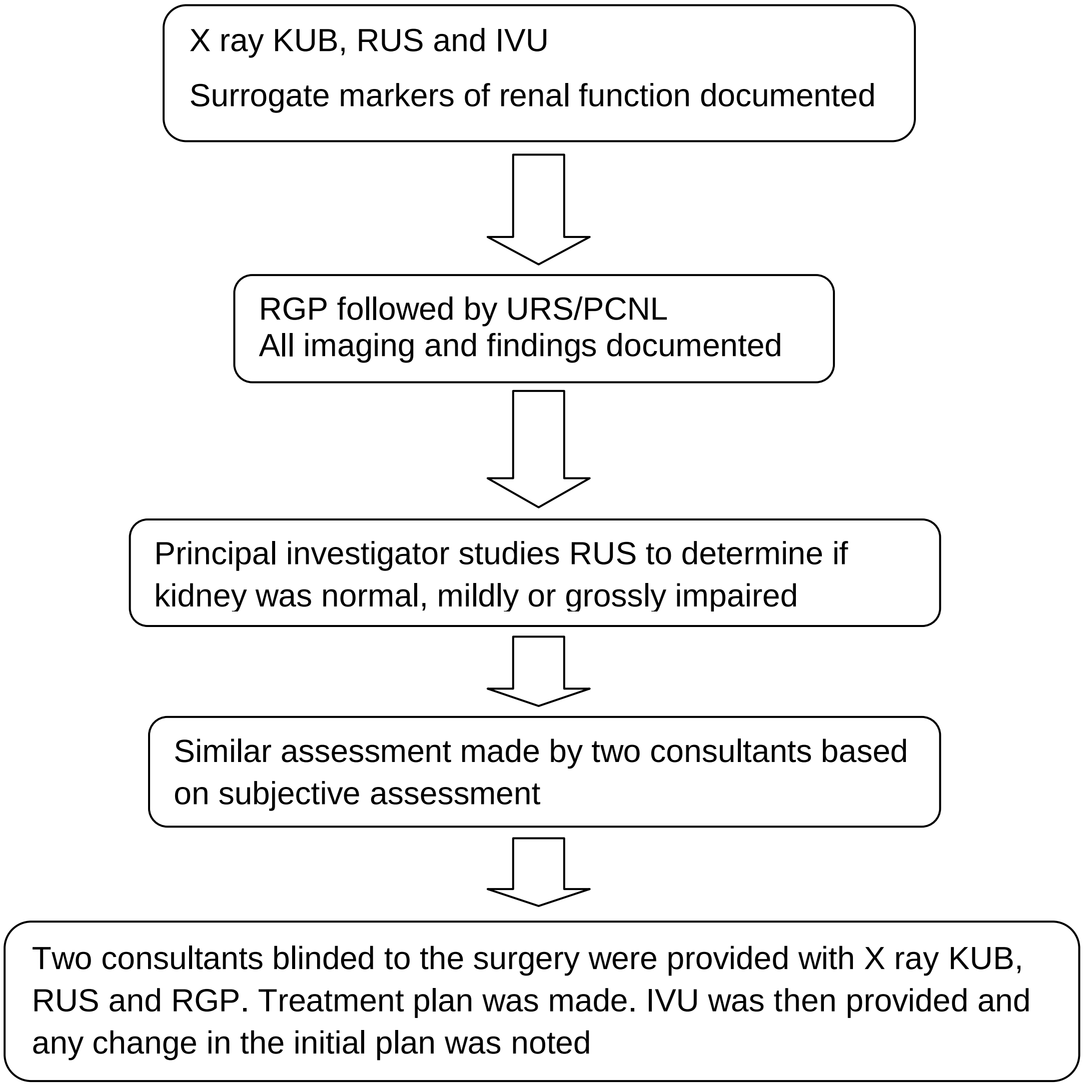
Precision (%) = 5

Desired confidence level (%) = 90

Required sample size = 144

Confidence Level (%)	Sample Size (N)
$4pq/d^2$	144

Note: With a prevalence of 10% of ureteric stone, with a precision at 5% and a desired confidence interval of 90% we need to study 144 subjects



Statistics: The sensitivity and specificity of the index test compared to the reference was presented. The agreement between index test and reference test was given using Kappa statistics for categorical outcomes. The degree of assessment between the primary investigator and the consultants and also agreement with regards to renal function was calculated using Kappa statistics. Finally degree of agreement between renal impairment nd degree of hydroureteronephrosis (HUN) on IVU would be calculated to determine whether RUS can give information about function of kidney

Procedural details

URS: Under general or spinal anesthesia

1. Patient is positioned in lithotomy position
2. Parts prepared with povidone iodine
3. Preoperative culture sensitive /broad spectrum antibiotic administered.
4. Cystscopy done with 20 Fr Storze scope
5. Desired ureteric orifice cannulated with 5fr Ureteric catheter over 0.028 inch glide wire
6. Retrograde pyelogram done
7. Ureteric catheter introduced beyond the stone to delineate proximal pelvicalyceal system.
8. Glide exchanged for Zebra of PTFE wire
9. Ureterscope 9/13.5Fr or 6/7.5 Fr introduced into the ureter with infant feeding tube in the bladder
10. Scope negotiated till the calculus
11. Calculus fragmented with pneumatic lithoclast /Holmium laser
12. DJ stenting done if required using 5/26 Fr stent
13. Per urethral catheter placed as per operating surgeon's choice

Percutaneous nephrolithotomy

1. Cystoscopy was done with 20 Fr Wolf scope and findings noted with patient in lithotomy position.

2. Desired ureteric orifice cannulated with 5fr ureteric catheter over glide wire and RGP performed.

3. Ureteric catheter placed in upper calyx.

4. 16F Foleys placed and ureteric attached to Foleys with adhesive.5 Fr infant feeding tube attached to the distal end of the ureteric catheter

5. Patient turned prone.

6. Appropriate puncture made.0.035 guide wire used to access into the PCS

7. Tract was dilated with Amplatz dilators upto 33Fr or balloon dilator (24 Fr) used for dilatation

8. 24Fr Storz scope/20 Fr Dresden scope used for the nephroscopy

9. Stone identified and fragmented using Ultrasonic /Pnematic Lithotripter.

10. Fragments removed with grasper.

11. Clearance assessed under image intensifier.

12. Stent placed if required

13. Nephrostomy placed as per operating surgeons assessment of clearance.

14. Post operative X-ray KUB done in the ward to assess clearance.

Fig 13: Arcadis varic image intensifier used in URS and PCNL

RESULTS

The sample size was 144 patients who underwent PCNL 94(52%) and URS 50(48%) for renal and ureteric calculus respectively

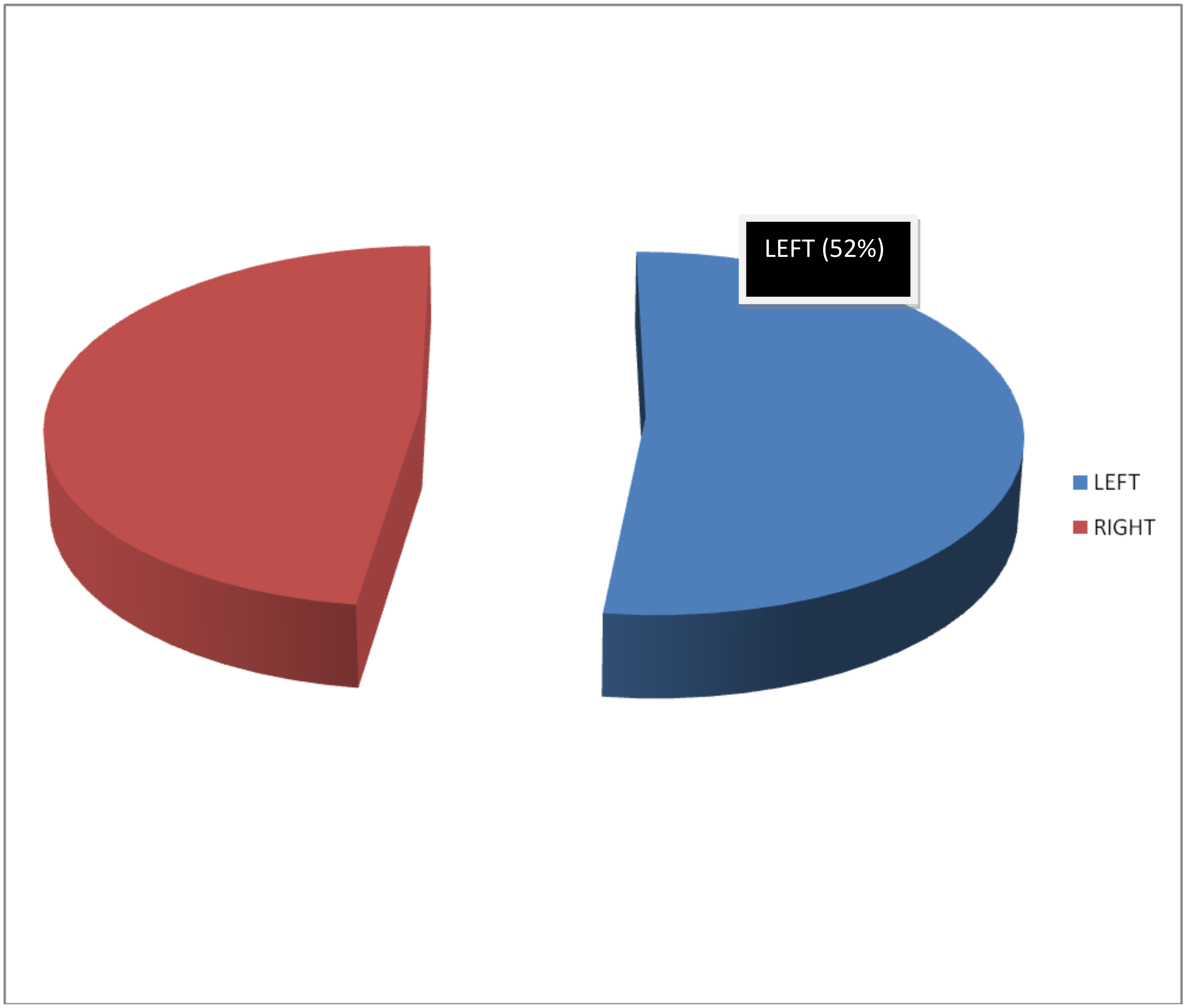


Fig 1.74 (52%) patients had left sided stone disease and remaining 70 had right sided urolithiasis

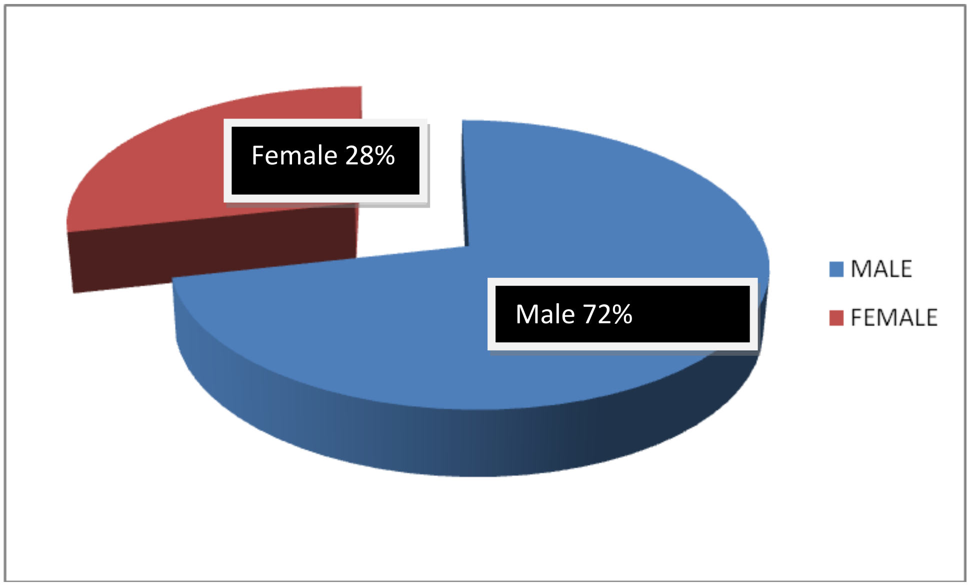


Fig 2 A total of 144 patients were included in the study out of 41(28%) which were women

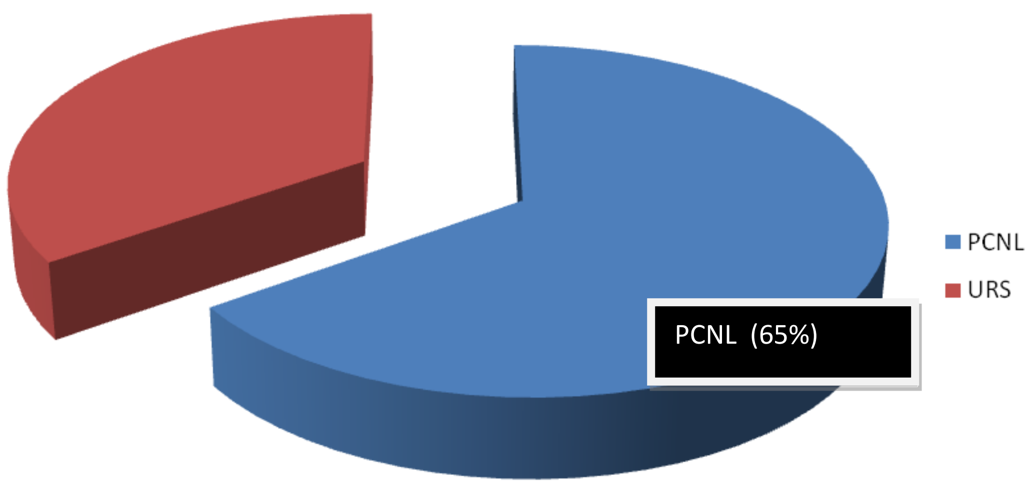


Fig 3. There were 94(65 %) patients who underwent PCNL and 50 (35%) patients underwent URS.

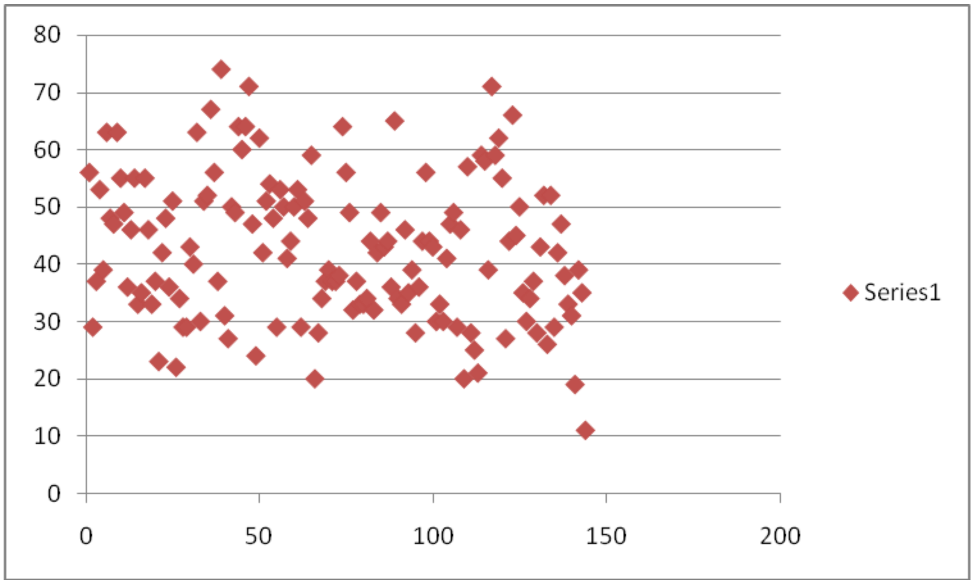


Fig 4.The mean age was 42.7 years (+/- 12.5 years)

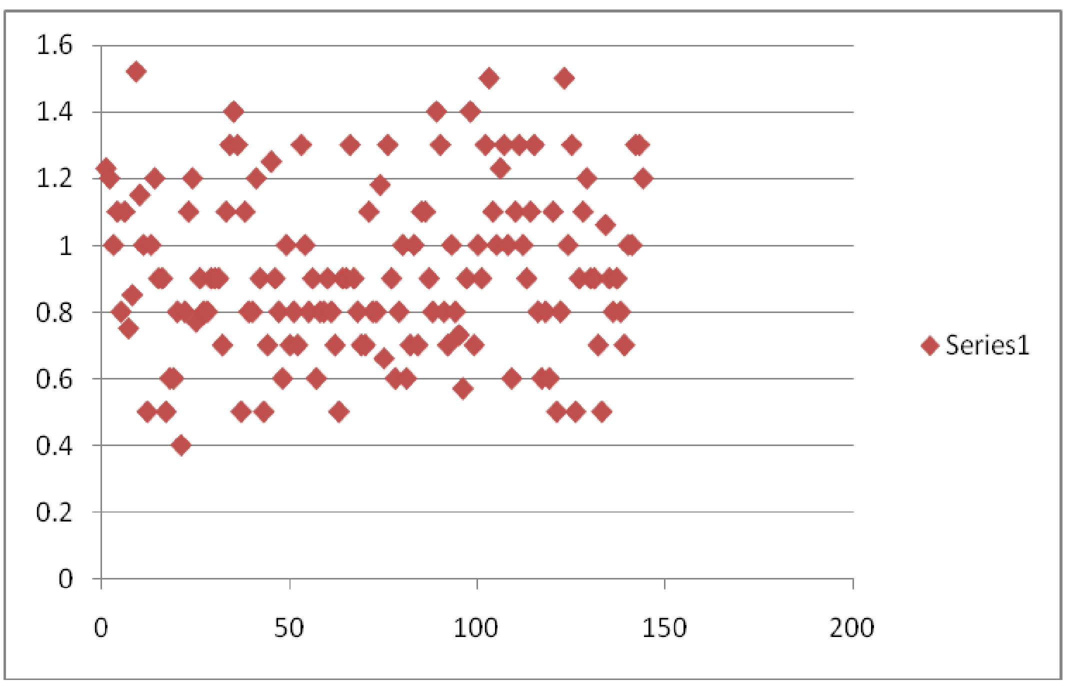


Fig 5.The mean serum creatinine was 0.92 mg% (+/- 0.25 mg %).

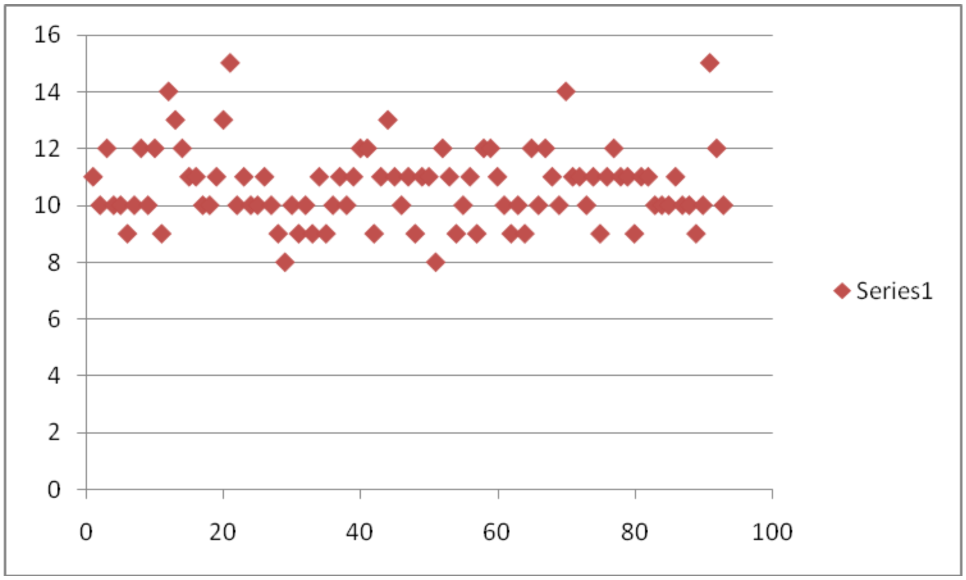


Fig 6. The mean renal size was 10.76 cm (+/-1.86 cm) in the PCNL group

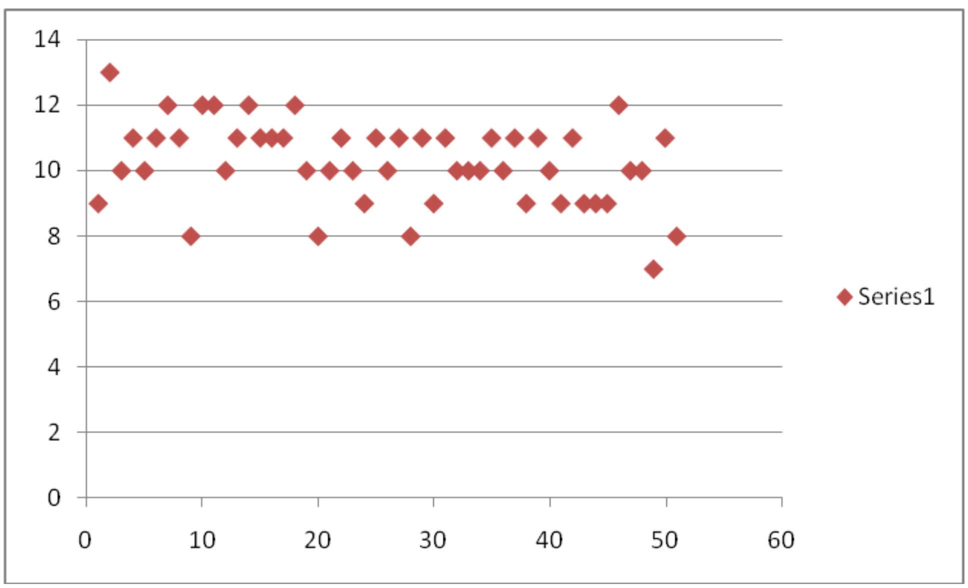


Fig 7.The mean renal size in the URS group was 10.85 cm (+/-1.57 cm)

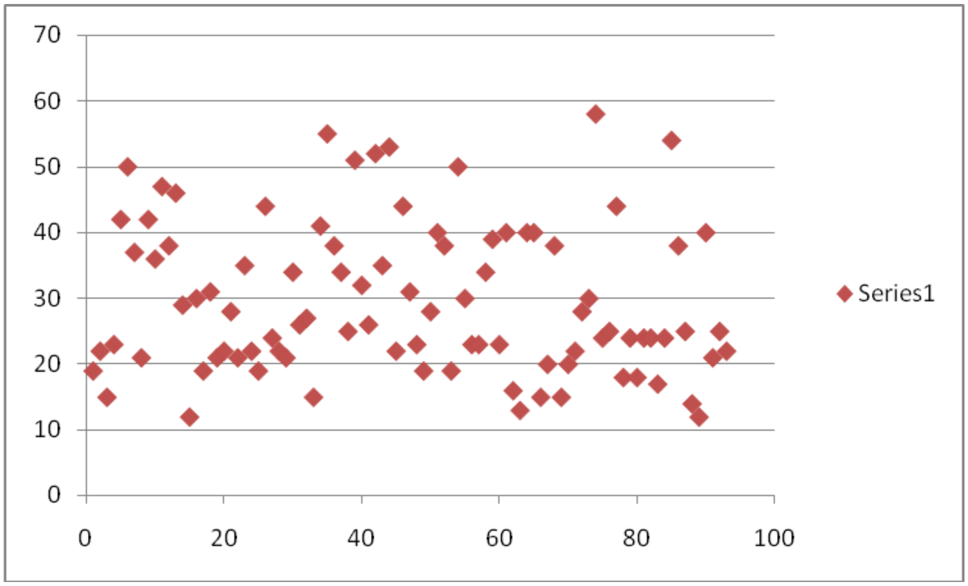


Fig 8. The mean calculus size was 29.8 mm (+/-11.34 mm) in the PCNL group

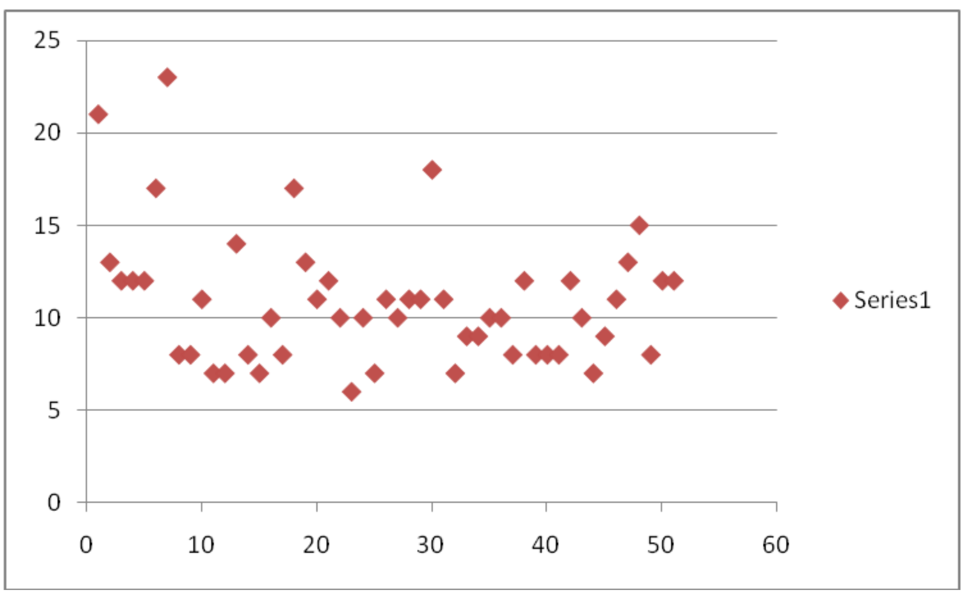


Fig 9 .The mean stone size was 10.76 mm (+/- 3.4 mm) in the URS group.

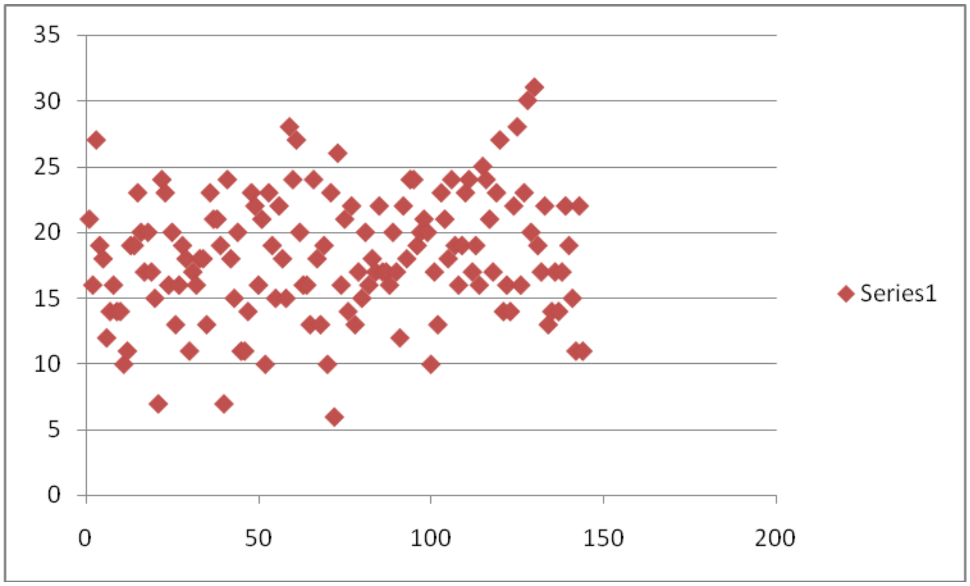


Fig 10. The mean parenchymal thickness of the upper pole was 18.15 mm (+/- 4.6mm)

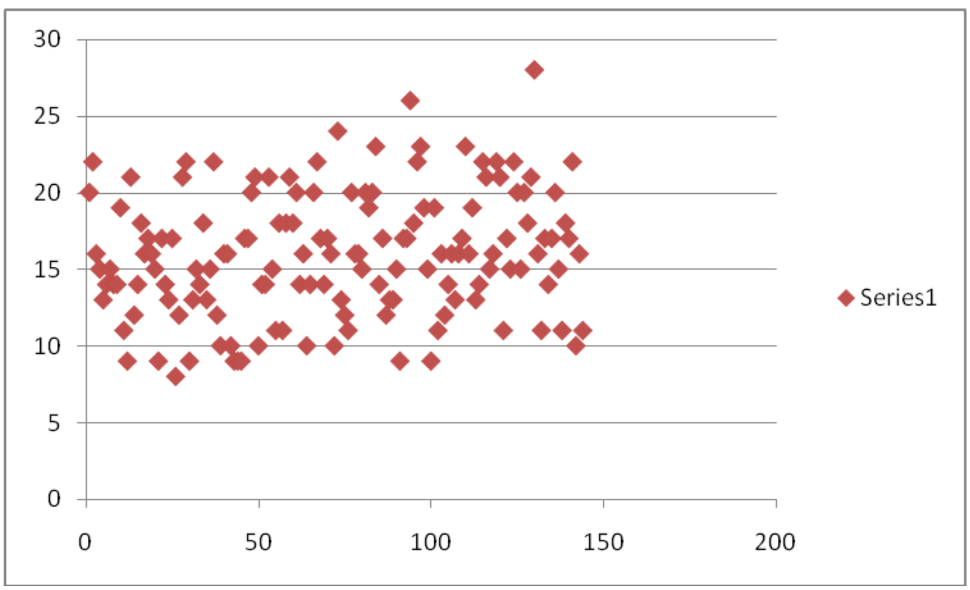


Fig 11. The mean parenchymal thickness of middle pole was 15.9 mm (+/- 4.9 mm)

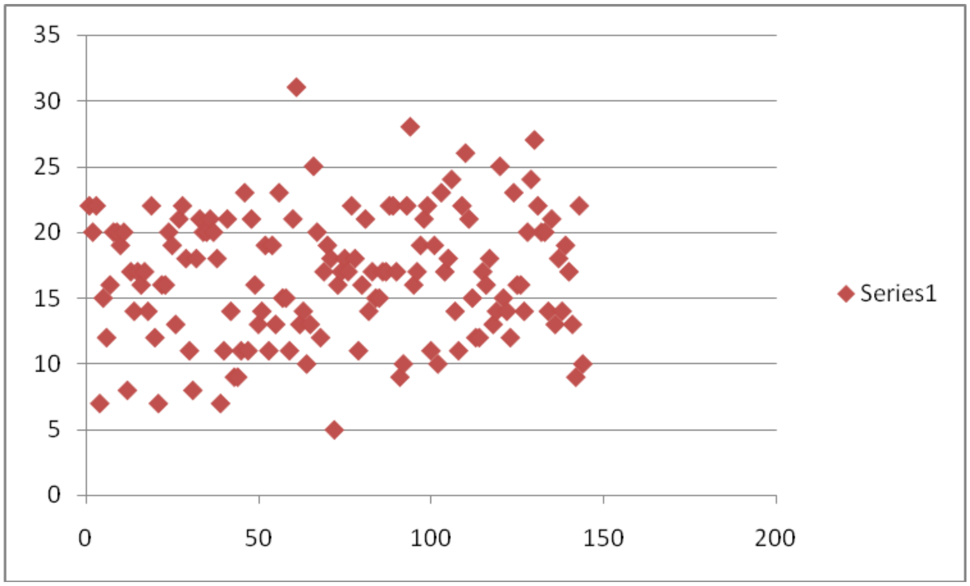
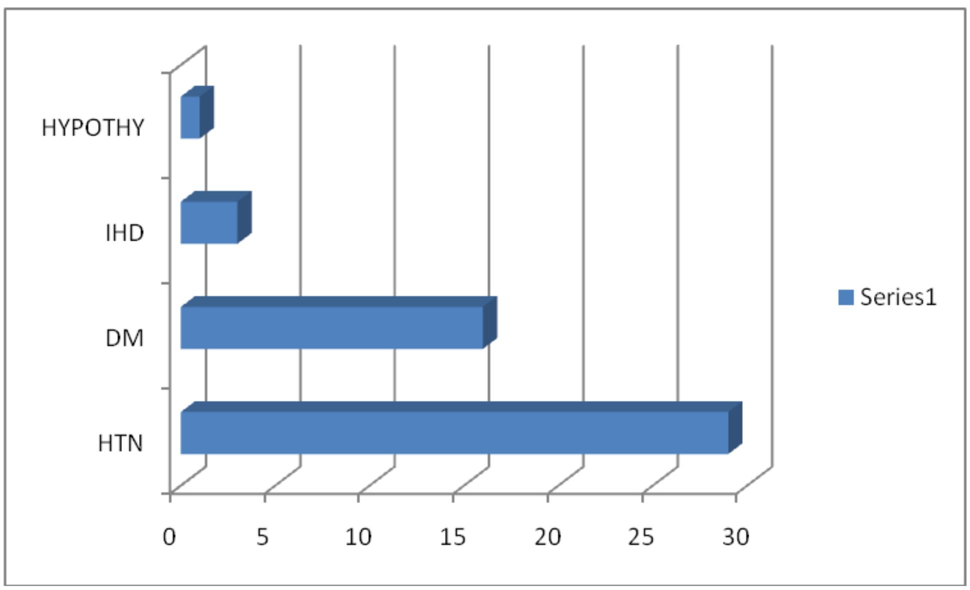


Fig 12.The mean parenchymal thickness of the lower pole was 16.65 mm (+/- 4.8 mm)

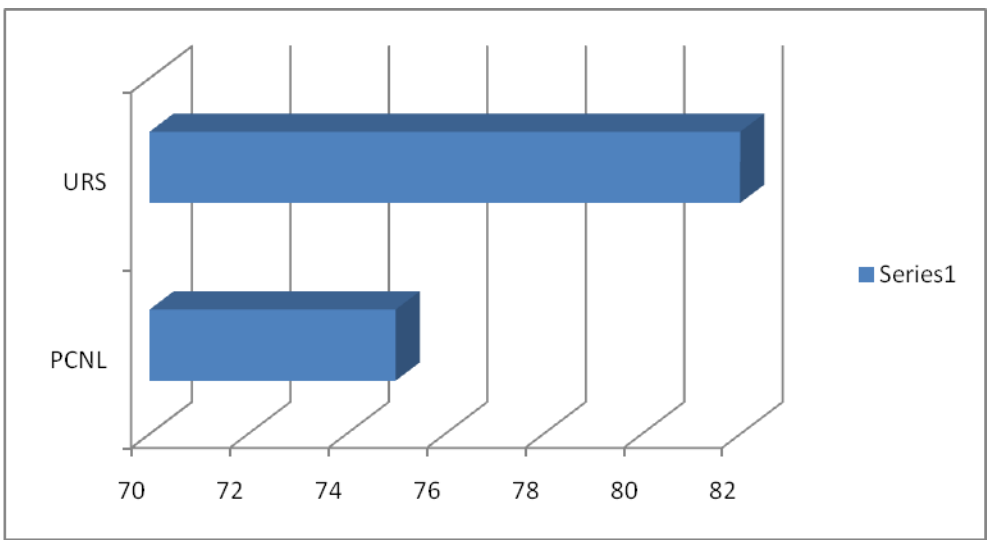


Co morbid conditions

Co morbid condition	Incidence
Hypertension	29 (20%)
Diabetes Mellitus	16 (11%)
IHD	3 (0.2%)
Hypothyroidism	1(0.01%)

Hypertension was the most common prevalent co morbid condition followed by diabetes mellitus

Stone free rate was 67(75%) for PCNL and 41(82%) for URS



Depending upon the four renal parameters, the affected kidney unit and contra lateral kidney was termed was normal (1), mild impaired (2) and grossly impaired (3) Two consultants also evaluated the renal units and gave a similar grading for the affected renal and contra lateral units

Table 1: Assessment evaluation of principal investigator and two consultants

Grade of affected renal unit using KUB RUS	Assessment by principal investigator N=144	Assessment and agreement by both consultants	Agreement by one at least consultant	Total disagreement
Normal	89	72	15	2
Mild impairment	45	12	25	8
Gross impairment	10	1	7	2

Renal grading between the two consultants were compared to check for agreement between the two to assess uniformity and exclude gross disparity in the renal architecture

<u>Table 2 Agreement between the Consultant 1 and 2:</u>

Degree of assessment consultant 1	Degree of assessment consultant 2				
	No impairment	Mild impairment	Gross impairment	Kappa Statistic	P-value
No impairment	77	18	1	0.2731	0.0001
Mild impairment	21	15	4		
Gross impairment	3	4	1		

The value of kappa is 0.2731, indicating a fair level of agreement between the consultant1 and consultant 2 with significant ($p<0.001$)

Then the each of the grading of the renal unit of the consultant was compared with the principal investigator to assess matching.

Table 3: Agreement between the Degree of assessment consultant 1 &principal Investigators assessment:

Degree of assessment Consultant 1	Principal investigator				
	No impairment	Mild impairment	Gross impairment	Kappa	P-value
No impairment	77	17	2	0.5073	0.0
Mild impairment	11	25	4		
Gross impairment	1	3	4		

The value of kappa is 0.5073, indicating a moderate level of agreement with significant p-value.

Table 4: Agreement between the Degree of assessment consultant 2 &principal investigator:

Degree of assessment Consultant 2	Principal investigator				
	No impairment	Mild impairment	Gross impairment	Kappa	P-value
No impairment	77	22	2	0.5020	0.0
Mild impairment	12	23	2		
Gross impairment	0	0	6		

The value of Kappa is 0.5020, indicating the moderate level of agreement with significant value

Comparison of renal units with drainage of kidneys was done to assess whether the renal parenchyma could serve as a surrogate for function

Table 5: Comparison of renal units with IVU drainage

Kidney affected N=144	Principal investigators assessment of renal unit	IVU drainage
Ipsilateral kidney	Normal (N=89)	Grade 1 = 77 (86.5 %)
		Grade 2 = 12 (13.5%)
		Grade 3 = 0
	Mild Impairment (N=45)	Grade 1 = 15(36.7%)
		Grade 2 = 30 (63.3%)
		Grade 3 = 0
	Moderate to gross impairment (N=10)	Grade 1 = 0
		Grade 2 = 6 (60%)
		Grade 3 = 4 (30%)

In the table 5. With normal and kidneys with mild impairment, the drainage was either prompt or had minimal delay (1or 2 film delay with mild clubbing).None of the kidneys which were normal on RUS had sever impairment on IVU. Hence it can be stated that with normal appearance on RUS, probability of severe changes on IVU is low.

On the other hand, the renal units which revealed severe impairment on RUS (N=10) none had normal IVU and they had moderate or severe changes on IVU

Table 6: Kappa value and odds ratio for RUS evaluation corresponding to IVU

IVU	Renal Ultrasound (RUS)			Kappa	P value	Odds ratio
	Normal	Mild	Gross			
Prompt	77	15	0			20.6
Mild delay	12	30	6	0.59	<0.001	CI
Gross delay	0	0	4			(9.24-46.18)

With change in RUS from normal to gross impairment the odd ratio was 20 of detecting an abnormality on RUS

Comparison of the contralateral kidney was done to assess global renal status

Table 7: Contralateral kidney status and IVU

Kidney affected N=143	Principal investigators assessment of renal unit	IVU drainage
Contra lateral kidney	Normal Kidney (N=125)	Grade 1 = 124 (86.7 %)
		Grade 2 = 1 (13.3%)
		Grade 3 = 0
	Mild Impairment (N=16)	Grade 1 = 10 (62%)
		Grade 2 = 6 (18%)
		Grade 3 = 0
	Moderate to gross impairment (N=2)	Grade 1 = 0
		Grade 2 = 1 (50%)
		Grade 3 = 1 (50%)

There were only 19 (13.2%) abnormal contra lateral kidneys and in these 19 abnormal kidneys there was mild delay in excretion in 8 (5%) and gross delayed excretion in one patient. There was prompt drainage in 124(86.7%) with normal contra lateral units while in patients with grossly abnormal kidneys there was delay in drainage.

Thus if 213 (84 ipsilateral and 124 contra lateral) renal units were considered normal on RUS, only 9(8 ipsilateral and 1 contra lateral) patients had abnormality on IVU. Therefore if a RUS was normal there was, only a 4% chance of finding an abnormality.

After studying the IVU, both consultants arrived at a final plan of management of the patient.

<u>Table 8: Agreement between the change in management consultant1 & change in mgmt consultant 2</u>:

Change in management consultant 2				
Change in management consultant 1	No	Yes	Kappa	P-value
No	120	5	0.0178	0.3987
Yes	18	1		

The value of kappa is 0.0178, indicating a Slight level of agreement between the consultant1 & consultant 2 with insignificant p-value.

In 23 patients, there was change in plan between two consultants following IVU due to the additional information provided by the test while in 121 patients IVU did not offer any change of plan. But finally, 8 patients with normal RUS and 8 patients with abnormal RUS underwent final treatment plan change.

Table 9: Change in plan in patients with normal RUS

Patient	USG	IVU	PLAN CHANGE
1-2	Grade 1	Grade II HUN	SWL to PCNL
3-4	Grade 1	Negative Pyelogram	SWL to URS in pt.3 Conservative to URS in pt.4
5-6-7	Grade 1	Narrow infundibulum	SWL to PCNL
8	Grade 1	Calculus not visualized on RUS.	Conservative to PCNL

In patient 1 and 2, there was presence of significant HUN (grade 2), hence plan was changed from shock wave lithotripsy to URS in order to relieve the obstruction and subsequently salvage the kidney.

In patients 3 an 4, the presence of negative pyelogram gave away the picture of obstruction .hence plan was changed from conservative management and SWL to URS in patients 3 and 4 respectively. But persistence of colic made a ordering of an IVU mandatory

In patients 5, 6 and 7, IVU revealed a narrow infundibulum draining the calyx containing calculus which was missed on RGP which would have made the initially the plan of SWL unsuccessful. Plan was changed subsequently to PCNL.

In the patient 8, a calculus which was not visualized KUB and RUS was detected on IVU and changing plan of conservative management to URS.IVU was ordered due to persistent detection of increased blood cells in urine.

As per figures mentioned in table 5, there were 89 patients with normal ultrasound and in only whom 12 (13.5%) patient has abnormal IVU which was mild delay in excretion. In the above 89 patients change in plan was only in 8 (9%) patients

Table 10: change in plan in patients with abnormal RUS

Patient no	RUS grade	IVU finding	Change of plan
1	Mild impairment	Favorable anatomy for puncture	SWL to PCNL
2	Mild impairment	Stone in upper ureter	PCNL to URS and PCNL
3	Mild impairment	Stone in calyceal diverticulum	SWL to PCNL
4	Mild impairment	Better evaluation of stone position in PCS with IVU	URS TO PCNL
5	Gross impairment	Gross caliectasis	Nephrectomy to PCN due to delayed drainage
6	Gross impairment	Large Stone burden ?Non functioning kidney	Nephrectomy to PCNL
7	Gross impairment	Delayed drainage with negative pyelogram	SWL to URS
8	Gross impairment	Delayed drainage with negative pyelogram	Nephrectomy to PCNL

In patient 1: Due to presence of unfavorable calyceal anatomy (infundibular width less than 5 mm and obtuse infundibulocalyceal angle) the initial plan of SWL was changed to PCNL

In patient 2: The initial plan which was just confined to PCNL after the IVU required PCNL with URS due to presence of stone in the upper ureter

In patient 3.: The plan made on the basis of USG and X ray KUB was SWL but a IVU revealed a calyceal diverticulum so in order to facilitate better stone clearance a PCNL was agreed upon

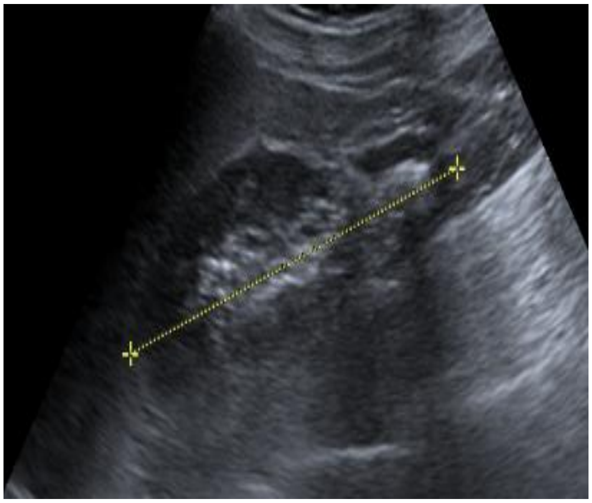
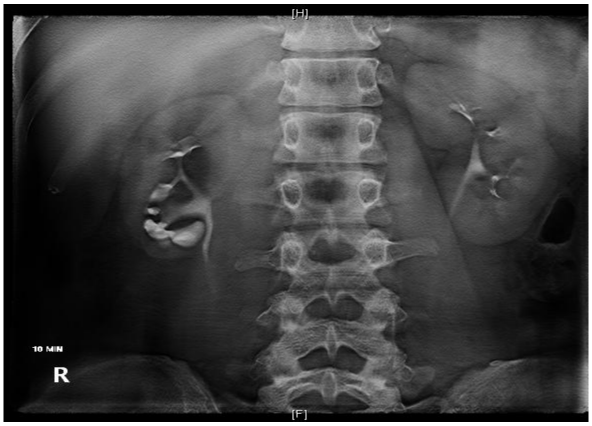


Fig A. Mild impairment on RUS



B. Calyceal diverticulum joining lower calyx of right kidney

In patient 4: IVU revealed that the stone was closer to the pelvis and hence easily accessible by PCNL rather than an ureteroscope and hence the change of plan.

In patient 5: there was gross caliectasis on RUS hence plan was initially to place a PCN followed by nephrectomy but then after IVU plan changed to PCNL

In patient 6: Due to large stone bulk the viability of the kidney was questioned but after IVU the both consultants came on a joint conclusion since the patient has a poor contra lateral kidney, he should be offered PCNL rather than nephrectomy

In patient 7: The initial plan of SWL was changed to URS when IVU revealed presence of a negative pyelogram necessitating an early intervention. In this patient there was gross abnormality of the renal architecture

In patient 8:RUS gave the picture of grade of grossly impaired renal function due to presence of large stone density in ureter.IVU revealed grade 3 HUN but with complete drainage of contrast hence plan was changed to URS and renal unit salvage

As per figure 5, there were 45(31%), patients with minimal impairment and 10(7%) patients with gross impairment on RUS. Normal excretion and mild delay in excretion was seen in 18(36%) and 27(64%) patients with mild impairment on RUS respectively. Mild delay and gross delay in impairment was seen in 6(60%) and 4(40%) respectively. Hence in 67% with abnormal RUS an additional finding could be detected.

Out of the 55 patients with impaired RUS there was change in only (15%) of the patients but a timely intervention was needed to salvage the kidney unit.

<u>Table 11: Additional findings on IVU missed on RUS</u>

Abnormality	Number N
Bifid pelvis	5
Extra renal pelvis	3
Pyelitis cystica	1
Calyceal diverticulum	1

Bifid pelvis

Pyelitis cystica

Fig RGP findings in patients undergoing URS N=50

Table 12: RGP grading and correlation to RUS and IVU

RGP grading	RUS grading	IVU severity of HUN
Grade1 :Proximal ureter well visualized N=42	Grade 1 N=32 Grade 2 N=10	Grade I N=29 Grade II N=13
Grade 2:Streak of contrast in proximal ureter N=4	Grade 1 N=1 Grade 2 N=3	Grade II-III HUN
Grade 3:Proxmal ureter not visualized N=4	Grade 3 N=3	Grade III-IV HUN

In 50 patients who underwent URS, 42(84%) patients had a well visualized proximal ureter while there was streak of contrast passing proximally and no visualization of the proximal ureter in 5(10%) and 3(6%) patients respectively. Here again RUS and RGP was able to predict patients in whom there would be significant abnormality in IVU. In 42 patients with good visualization of the proximal ureter there were 32 (76%) patients with normal RUS and 29(69%) patients with prompt excretion on IVU. In patients with just streak of contrast passing proximally, 4(80%) patients had kidneys with mild impairment and all 5 had grade 2-3 HUN on IVU. In all the 3 patients in whom proximal ureter was not visualized, there was gross impairment on RUS and IVU revealed grade 3-4 HUN.

Table 13: RGP indicating the level of HUN

RGP	HUN			Kappa	p-value
	1	2	3		
1	29	13	0	0.26	0.003
2	3	1	0		
3	0	0	4		

In the above table, RGP grading was consistent with the level of obstruction and there by the degree of the drainage with kappa value of 26% at a statistically significant P=0.003

Table 14: RUS grading and degree of HUN on IVU

RUS grading of kidneys	HUN on IVU			Kappa	p-value
	1	2	3		
1	27	6	0	0.56	<0.001
2	5	8	0		
3	0	0	4		

In the above table, there was 78% agreement between RUS grading and by the degree of the drainage with kappa value of 56% at a statistically significant P <0.001

Hence in patients with normal kidneys and RGP a good calyceal anatomy can be delineated and in patients with greater degree of HUN, there is more chance of having an abnormal kidney on RUS and poorer delineation on RGP

Table 15:KUB and RGP versus IVU in planning calyceal punctures.

<table>
<tr><td rowspan="4">PCNL</td><td rowspan="2">Puncture could be placed after X ray KUB and RGP

N= 92</td><td>Change after IVU

N=36 (40%)</td></tr>
<tr><td>No change after IVU

N=56(60%)</td></tr>
<tr><td rowspan="2">Plan could be decided on basis of X ray KUB and RGP

N=2</td><td>IVU helpful

N= 94</td></tr>
<tr><td>IVU not helpful

N= 0</td></tr>
</table>

<u>Table 16: Puncture evaluation after RGP and KUB and IVU</u>

Puncture with IVU	Puncture planned with X ray KUB and RGP				Kappa	p-value
	1	2	3	4		
1	0	0	3	0	0.32	<0.001
2	1	4	5	0		
3	3	11	52	6		
4	0	0	1	7		

In the table above, there was a 69% agreement between the two groups in planning the puncture and the kappa value was 32 % at a statistically significant $P<0.001$

Hence on the basis of RGP and X ray KUB a fairly good estimate of the calyx for puncture could be assessed in the absence of the IVU.

Discussion

Imaging of the urinary tract is pivotal in the diagnosis, management, and follow-up of patients with urolithiasis. Historically, urologists have used a variety of imaging modalities, including plain radiography of the kidneys, ureters and bladder (KUB), IVU, ultrasound (US), magnetic resonance urography (MRU) and computed tomography (CT), each with its advantages and limitations This study was done to assess the overwhelming need to carry out functional study in all patients prior to URS or PCNL and thereby subject them to the harmful effects of radiation and contrast administration. This study aimed to ascertain whether parenchyma thickness, echogenicity degree of pelvicalyceal separation on RUS, ureteric and calyceal anatomy on RGP and position of and nature of the stone on X ray KUB could be cumulatively used to give all information generated by CECT or IVU

Also prospective study we wish to evaluate the role of IVU and the incremental benefit in patients undergoing URS or PCNL for management of stone disease. We will also identify, if there is a subgroup of patients who would benefit from IVU prior to intervention, based on history, presentation, stone characteristics on USG and KUB.

Out of total sample size of 144, 95(65%) patients underwent PCNL and 50(35%) patients underwent URS. Out of the 144 patients, according to the principal investigators evaluation there was normal and abnormal ultrasound in 89(61%) and 55(39%) patients respectively. There was agreement between both consultants and the principal investigators evaluation with respect to involved renal unit involved (p=0.0).

In 89 patients with normal RUS, there was change of plan only in 8(9%) patients who underwent change in the treatment suggested on the basis of X ray KUB RUS, RGP alone(table 8). In the remaining, 81(91%) patients the plan of treatment remained unchanged and the above 3 imaging tests were enough to suggest appropriate management.

In evaluation of 143 contralateral kidneys, RUS was normal in 124 patients and in only one patient IVU revealed delayed drainage.

Thus on evaluation of both affected and contra lateral kidneys if RUS is normal there is only 4 % chance on finding an abnormality on IVU

In patients with abnormal RUS, 8 (14.5%) patients underwent change in plan (table 9.) in rest of the 47(85.5%); IVU did not make any change in plan.

In patients undergoing URS, 42(84%) patients had normal RUS and RGP revealed good visualisation of the proximal ureter. In the remaining 8 patients, there were 4 patients in whom streak of ureter delineated and there was no visualization of the proximal ureter in 4 patients. In both the above groups, RUS revealed mild and gross abnormality. Hence restricting the IVU's to only those who have an abnormal RUS can safely reduce. In such patients we would suggest an inclusion of a prior IVU to delineated function and administer emergency measures to salvage kidney function

The amount of radiation in IVU is approximately 10 times that of plain radiography of the abdomen and pelvis and many patients may receive an additional radiation dose with follow-up studies (if a calculus is not expelled) or with new episodes of colic. Sonography is a radiation-free diagnostic tool that can be very accurate. According to Park et al the overall diagnostic sensitivity, specificity, and accuracy of sonography were 98.3%, 100%, and 98.4%, respectively[40].

Evaluation of punctures on basis of comparison to revealed that 92 patients puncture could be planned on the basis of RGP and X ray KUB. In two patients there was incomplete delineation of the PCS on RGP (impaction of calculus, but RUS revealed HN).All 94 patients IVU was helpful in planning puncture preoperatively and additional punctures to facilitate. But on comparison between the two groups there was high level of agreement indicating in the absence of IVU a well performed RGP and X ray KUB can facilitate puncture.

Strengths of the study

1-Single centre prospective trial involving evaluation of both kidney units by consultants with good amount of experience in endourological procedures

2-Evaluation of all patients with 4 modalities i.e. RUS, X ray KUB, RGP and IVU. So in patients with obstructed kidneys managed with optimum care could be given

3-Attempt to minimise radiation and contrast exposure in patients who have normal renal architecture and echogenicity

Limitations of the study

1-Gold standard imaging, CECT was not performed on the patients

2-Only patients planned for endourological management of stones were included in the study (URS and PCNL)

3-To ensure documentation with RGP, impact of this algorithm on those for ESWL were not captured

Conclusions

1-When RUS is normal there is a 4% chance of finding and abnormality, but there was no change in plan. As the RUS degree changes from normal to gross impairment the odds ratio of finding an abnormality on IVU is 20

2-When the RUS is abnormal, there is a 14% chance of detecting an abnormality on IVU .Hence in such patients a prior IVU or CECT may be indicated

3-The degree of abnormality on RUS can provide a picture about the degree of obstruction in ureteral calculi. In patients with higher grade of renal parenchymal disparity have higher degree of obstruction to drainage (kappa 56% at p value of <0.001)

4-X ray KUB and RGP can be used to plan punctures prior to PCNL (kappa 32 at p value <0.001)

5-Calyceal diverticulum and bifid pelvis may be missed in RUS

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Annexure I: Information sheet

Respected Sir/Madam

Greetings

I would like to invite you to participate in my study: Functional assessment prior to stone surgery is it necessary? As you as patients undergoing stone surgery, there is a need of functional assessment of the urinary system prior to surgery in the form of Intravenous Urogram (IVU) or contrast enhanced computed tomography. Although functional imaging provides us to plan the required surgery, it is not without its side effects with the major ones being radiation exposure and risks of contrast administration.

In this study, we would like to compare your imaging after your surgery mainly your Ultrasonography and X ray KUB with functional study you would have undergone (IVU/CECT) .We would like to infer did functional assessment change the initial plan after X-ray KUB and Ultrasonogram.

If found positive we will be able to do perform stone surgery only on the basis of X-ray and ultra sonogram and thus be able to do away with harmful effects of radiation and contrast administration.

You as participants do not have to undergo any new tests on interventions in this study. There will not be any delay or change in the treatment options given to you. You treatment will continue as scheduled even if you refuse participation in this study.

Any queries you have will be thoroughly explained by me as the principal investigator. The identities of the patients will be kept confidential and will not be released during publication of the results of the study

Annexure 2

Format for Informed Consent Form for Subjects

Informed Consent form to participate in a research study

1. **Study Title: Pre operative imaging prior to ureterorenoscopy (URS) and percutaneous nephrolithotomy (PCNL): Can plain X-ray KUB, renal ultrasonography (RUS) and retrograde pyelography (RGP) be an equivalent alternative for intravenous urography (IVU)?**

Study Number: ____________

Subject's Initials: __________________

Subject's Name: ____

Date of Birth / Age: ___________________________

(Subject)

(i) I confirm that I have read and understood the information sheet dated ____________ for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I understand that the Sponsor of the clinical trial, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published.

(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

(v) I agree to take part in the above study.

(vi) I am aware of the Audio-visual recording of the Informed Consent.

Signature (or Thumb impression) of the Subject/Legally Acceptable

Date: _____/_____/______

Signatory's Name: ________________________ Signature:

Representative: __________________

Date: _____/_____/______

Signatory's Name: ___________________________________

Signature of the Investigator: _________________________

Date: _____/_____/______

Study Investigator's Name: __________________________

Signature (or) thumb impression of the Witness: ____________________________

Date: _____/_____/_______

Name and Address of the Witness: _______________________________

Consent was also translated into Bengali and Tamil.

Main Excel Sheet

plan aft	plan aft	Assessmen	Procedure pla	Any change	Any change in plan after IVU			Name	hospital nu	age	SIDE	SITE	SIZE KI	NUMBER	UP	MP	LP	HUN	ECHO	CALYX	CREAT	ivu	HN	HUN	drain
NA	CS	L1	L URS	No	No			Babita devi	791023F	28	left	lu	13	1	24	18	16	no	nor,m	nc	0.73		no	no	partial
NA	CS	L1	L URS	No	No			amritlal	837067f	36	left	lu	10	1	19	22	17	no	norm	lu	0.57		no	yes	prompt
NA	CS	R1	R URS	No	No			Ram Prasad	786068F	44	right	lu	11	1	20	23	19	no	norm	nc	0.9		no	yes	prompt
CS	NA	L1	L st PCNL	No	No			Rajendra	800243F	53	left	pelvis	10	1	19	15	7	hn	norm	pel	1.1		yes	no	delayed
CS	NA	R1	R PCNL	No	No	Radiolucent, prob shoud		Vanitha	606759d	65	right	pelvis lc	9	1	20	13	22	no	norm	pel	1.4		yes	no	delayed
CS	NA	R1	R PCNL	No	No			pranab	867783f	39	left	pelvis	10	1	18	13	15	hn	norm	ip lc	0.8		yes	no	delayed
NA	CS	R1	R PCNL	No	No			sanat	856031f	63	right	pel all cal	9	1	12	14	12	hn	norm	pel all ca	1.1		yes	no	prompt
NA	CS	R1	R PCNL	No	No			dinesh	885458f	34	right	pel lc mc	10	2	17	15	17	hn	norm	pel mc lc	1.3		yes	no	prompt
NA	CS	L1	L PCNL	No	No			chandan	823244f	56	left	pel	11	1	21	20	22	hn	norm	lc	1.23		yes	no	prompt
NA	CS	R3	R PCNL	No	No			Sumana	860342f	33	right	pel	15	1	12	9	9	hn	norm	pel	0.8		yes	no	delayed
NA	CS	R2	R PCNL	No	No			sova	860377f	48	right	all cal	10	3	14	15	16	hn	norm	uc mc lc	0.75		yes	no	prompt
CS	NA	R1	R URS	No	No			Subhan	197661B	56	right	uu	10	1	21	19	21	hun	norm	uu	1.4		no	yes	delayed
CS	NA	R1	R PCNL	No	No			Mahabir	803539F	47	right	pel lc	12	2	16	14	20	no	norm	pel lc	0.85		no	no	prompt
NA	CS	R1	R URS	No	No	R dilated lower ureter RGP picked, US			786068F	44	right	lu	9	1	20	17	22	no	norm	lu	1		no	no	prompt
NA	CS	R2	R PCNL	No	No			Phulendra	801797f	63	right	pel mc lc	10	2	14	14	20	hn	norm	pel lc mc	1.52		yes	no	prompt
AJPG	CS	R2	R PCNL	No	No			Amodevi	846846F	55	right	pel mc lc	12	3	14	19	19	hn	norm	pel lc mc	1.15		yes	no	prompt
NA	CS	R1	R PCNL	No	No			Nishit	849796F	49	left	pel mc lc	9	1	10	11	20	hn	norm	pel all ca	1		yes	no	prompt
AJPG	CS	L3	L PCNL	No	No	Good example		Afsak	664989C	43	right	uu	12	1	10	9	11	hn	norm	uu	1		yes	mild	prompt
AJPG	CS	L1	L PCNL	No	No			Habibur	850093f	29	left	pel lc	10	2	16	22	20	hn	norm	pel lc	1.2		yes	yes	prompt
AJPG	CS	R3	R PCNL	No	No			chanda	858532f	36	right	pel lc	14	2	11	9	8	hn	norm	pel lc	0.5		yes	no	delayed
								abdul kudd	628723d	46	right	lc	13	1	19	21	17	no	norm	lc	1		yes	no	prompt
AJPG	CS	L1	L URS	No	No			Prabhu	901920f	30	left	lu	11	1	17	19	19	hun	norm	lu	0.9		yes	yes	prompt
								Babar ali	120618g	55	left	uc mc lc	12	4	19	12	14	hn	norm	uc mc lc	1.2		yes	no	prompt
NA	CS	L1	L PCNL	No	No			nurul	867796f	33	left	lc	11	1	23	14	17	no	norm	lc	0.9		no	no	prompt
NA	AJPG							guna	823600F	35	left	all cal	11	3	20	18	16	hn	incres	uc mc lc	0.9		yes	no	prompt
NA	AJPG							Kamala	411177d	55	right	pel	10	1	17	16	17	no	norm	pel	0.5		no	no	prompt
NA	AJPG							jinu	826455f	46	right	pel lc	10	1	20	17	14	hn	norm	pel lc	0.6		yes	no	delayed
CS	AJPG	L1	L PCNL	No	No			deojit	833522f	33	left	lc	11	1	17	16	22	no	norm	lc	0.6		no	no	prompt
CS	NA	L1	L PCNL	No	No			dipu	870780F	37	left	lc	23	1	15	15	12	no	norm	lc	0.8		no	no	prompt
CS	NA	L3	L PCNL	No	No	Good example		khemati	870786f	23	left	lc mc	15	2	7	9	7	hn	norm	lc mc	0.4		yes	no	delayed
AJPG	CS	L2	L URS	No	No	Radiolucent, prob shoud		manoranjan	870156F	33	left	uu	8	1	13	11	10	hun	incres	uu	1.3		no	yes	delayed
NA	AJPG							rafiqul	919254B	42	left	pel	10	1	24	17	16	hn	norm	pel	0.8		yes	no	prompt
NA	AJPG							rama shan	876866f	30	right	uu	12	1	23	16	23	hun	norm	uu	1.5		no	yes	delayed
								Ningma	130356g	48	left	pel	11	1	23	14	16	hn	norm	pel	1.1		yes	no	prompt
CS	NA	No USG						krishna	878679f	36	left	pel lc	10	2	16	13	20	no	norm	pel lc	1.2		yes	no	prompt
CS	NA	R1L1	BL PCNL	RGP not cle	No			narayani	810058F	51	left	pel uc mc	10	1	20	17	19	no	norm	pel uc mc	0.77		no	no	prompt
AJPG	CS	L2R1	BL PCNL	No	No			gokul	848377b	22	right	pel lc mc	11	3	13	8	13	hn	norm	pel lc mc	0.9		yes	no	prompt
AJPG	NA							ramu	872040F	41	right	uu	12	1	21	12	17	hun	norm	uu	1.1		no	yes	prompt
AJPG	NA							rose	902048f	47	left	lu	10	1	18	14	18	hun	norm	lu	1		no	yes	prompt
								Bipul	116074G	34	right	mc	10	1	16	12	21	hn	norm	mc	0.8		yes	no	prompt
NA	CS	RIL1	L PCNL	No	No			Ulaganatha	759908f	29	left	lc mc	9	2	19	21	22	no	norm	lc mc	0.8		yes	no	prompt
CS	NA	L2	L URS	No	No			arafa	880191f	49	left	lu	11	1	24	16	24	hun	norm	lu	1.23		no	yes	delayed
AJPG	NA							Backiaraj	473829f	29	left	lc	8	2	18	22	18	no	norm	lc	0.9		no	no	prompt
NA	CS	?Radiolucent calculus						Bhagirath	818331f	29	right	lu	12	1	19	13	14	hun	norm	lu	1.3		no	yes	prompt
								Gita	584697d	43	left	pel	10	1	11	9	11	hn	norm	pel	0.9		yes	no	delayed
NA	CS	R2	R PCNL	No	No			Dinesh	897227F	40	right	all cal	9	3	17	13	8	no	norm	all cal	0.9		no	no	prompt
CS	AJPG	R2	R PCNL	No	No			sarojamm	867941f	63	right	all cal	10	2	16	15	18	no	norm	all cal	0.7		yes	no	delayed
								Milan	131270g	30	right	pel	9	1	18	14	21	hn	norm	pel	1.1		yes	no	prompt
CS	AJPG	L1R2	BL PCNL	No	No			abdul kalam	768206F	51	left	pel all cal	11	1	18	18	20	no	norm	pel all ca	1.3		yes	no	prompt
NA	CS	L1R1						biswanath	869143f	46	left	lu	11	1	16	16	11	no	norm	lu	1		no	yes	delayed
CS	NA	L1R1						christy	461712D	20	left	lu	11	1	19	17	22	hun	norm	lu	0.6		no	yes	prompt
AJPG	CS	R3L2	?R nephrecto	No	No			fatik	861641f	52	left	pel all cal	9	1	13	13	20	no	norm	pel all ca	1.4		yes	no	delayed
					No			Jagananada	555762b	67	right	pel uu	10	3	23	15	21	hn	norm	pel uu	1.3		yes	no	prompt
NA	AJPG							mahaber	002090g	56	left	pel lc	11	1	21	22	20	hn	norm	pel lc	0.5		yes	no	prompt
AJPG	CS							subrata	899290F	37	right	pel	10	1	21	12	18	hn	norm	pel	1.1		yes	no	prompt
AJPG	NA							kalyani	888261F	57	left	lu	11	1	23	23	26	hun	norm	lu	1.1		no	yes	delayed
CS	NA	R1L2	L URS					Joya	895431f	28	left	lu	12	1	24	16	21	hun	norm	lu	1.3		no	yes	delayed
NA	AJPG							charubala	006334g	74	right	pel lc	11	2	19	10	7	hn	norm	pel lc	0.8		yes	no	delayed
NA	AJPG							abhimanyu	473503f	31	right	pel lc	12	3	7	16	11	hun	norm	pel lc mc	0.8		no	yes	delayed
NA	AJPG							manoj	807939D	27	left	pel lc	12	3	24	16	21	hn	norm	pel lc	1.2		yes	no	prompt
AJPG	NA							pradip	003591g	25	right	lu	10	1	17	19	15	hun	norm	lu	1		no	no	prompt
NA	NA	R1						Riajul	892879f	37	right	lc	12	1	27	16	22	no	norm	lc	1		no	no	prompt
NA	AJPG							braja	016559G	50	right	pel uc mc	9	2	18	10	14	hn	norm	pel uc mc	0.9		yes	no	prompt
AJPG	NA							farida	000836g	49	right	pel lc	11	2	15	9	9	hn	norm	pel lc mc	0.5		yes	no	prompt
CS	AJPG	R2L1	R PCNL	No	No			Kanta	010318g	64	right	all cal	13	5	20	9	9	hn	norm	all cal	0.7		yes	no	prompt
AJPG	NA							krishna	017337G	21	right	lu	8	1	19	13	12	hun	norm	lu	0.9		no	no	prompt
CS	AJPG	L2	L PCNL	No	No			mathura	882118F	60	left	pe	11	1	11	9	11	hn	norm	pel	1.25		yes	no	prompt
AJPG	NA							selvaraj	858700f	64	left	pe	10	1	11	17	23	hn	norm	pel	0.9		yes	no	prompt
AJPG	NA							perianan	219885C	59	left	lu	10	1	16	14	12	hun	norm	lu	1.1		no	yes	prompt

pcs	size	RGU	other	Procedure	HUN	HN	HUN	comorb	opp kidney	OPP URETER	previo	P cons	IMPACTN	IVU FW	STENT	REASON	USG KUB	ADDITIONAL IVUINFO	STONE CLEARANCE	Puncture	NO OF PUNCTURES	DILATED
extra renal pelvis	13	1	no	urs	no	no	no	nio	normal	normal	nil	gener	2	NO	2		LU CAL	FULLNESS OF PCS	2			
normal	12	1	no	urs	no	no	yes	no	normal	normal	nil	vivek	2	NO	2		LU CAL	BIFID PELVIS	2			
normal	12	1	vuj narrow	urs	yes	no	yes	dm	normal	normal	cystolith	AD	2	NO	1	2	LU CAL	NO	2			
caliectasis	23	5	fillin dfect	pcnl	no	yes	no	dm htn	cal 8,2 mm	normal	ss pyl	gener							2	4	2	1
normal	12	4	fillin dfect	pcnl	no	YES	no	HTN	normal	normal	nil	gener							2	3	1	3
nomal	42	4	fillin dfect	pcnl	no	yes	no	nil	normal	normal	nil	anuj							1	3	1	3
normal	50	4	fillin dfect	pcnl	no	yes	no	dm htn	normal	normal	nil	AP							2	1,2	2	1,2
normal	40	4	fillin dfect	pcnl	no	yes	no	HTN	normal	hun	nil	NK							2	3	1	3
normal	19	4	nil	mini perc	no	yes	no	HTN	normal	normal	nil	NK							2	2	1	2
normal	21	5	fillin dfect	pcnl	no	yes	no	no	normal	normal	nil	anuj							2	2	1	2
normal	37	4		pcnl	no	yes	no	ni	normal	normal	ss pyl	NTJ							2	2	1	2
normal	12	2	filli defcet	urs	yes	NO	yes	IHD	normal	normal	opens	sagar	2	YES	1	2	UU CAL 2 IN NO	OBSTRUCTED SYSTEM	1			
Caly wide inf dist	21	4	fillin defect	pcnl	no	no	no	no	normal	normal	nil	vivek	2					NO	2	3	1	3
normal	12	1	narr dis u	urs	no	yes	no	DM	normal	normal	ss pcnl	AD	2	NO	1	2	LU CAL	HUN NOT PRESENT ON USG				
dilated	42	5		pcnl	no	yes	no	HTN	cyst	normal	nil	sagar							1	1,3	2	1
puj stric	36	4	puj narr	pcnl	no	yes	no	no	normal	normal	nil	rajadoss							2	3	1	3
normal	47	4	nil	pcnl	no	yes	no	no	staghorn	normal	nil	vivek							2	3		3
dilated	23	2	fillin dfect	urs	no	yes	no	no	staghorn	normal	pyl pcnl	NTJ	1	NO	2		UU AND OPP RENAL CAL	NO	2			
dilated	22	4	fillin dfect	mini perc	no	yes	yes	no	normal	normal	nil	NTJ							2	3	1	3
dilated	38	5	fillin dfect	pcnl	no	yes	no	no	cyst	normal	nil	NA							1	3	1	3
polycali thic u	46	4	nil	pcnl	no	yes	u thick	DM	normal	normal	nil	NA							2	3	1	3
stand colum	8	1	nil	urs	no	no	no	no	normal	normal	nil	gener	2	YES	1	2	LU CAL	OBSTRUCTED SYSTEM	2			
caliectasis	29	4	nil	pcnl	no	yes	no	no	normal	normal	nil	gener						no	2	1,3	2	1,3
normal	12	4	fillin defct	pcnl	no	no	no	no	normal	normal	nil	gener							2	3	1	3
PUJ strict	30	5	puj scarr	pcnl	no	yes	no	no	hun	calculus	nil	gener							2	3	1	3
normal	19	4	nil	pcnl	no	no	no	no	normal	normal	nil	gener							2	1,3	2	1,3
normal	31	4	nil	pcnl	no	yes	no	dm htn	normal	normal	nil	RPM							2	2,3	2	2,3
caliectasis	21	4	nil	pcnl	no	no	no	no	normal	normal	nil	RPM							2	3	1	3
normal	22	4	nil	pcnl	no	no	no	no	normal	normal	nil	anuj							2	3	1	3
gross caliectasis	28	5	jet sign	pcnl	no	yes	no	no	normal	normal	nil	RPM							2	2	1	2
hun	8	1	nil	urs	yes	no	yes	no	cyst	normal	nil	RPM	2	YES	1	2	UU CAL	NO	2			
HN	21	4	nil	pcnl	no	yes	no	HTN	normal	normal	nil	SKS							2	3	1	3
bl hun	11	1	nil	urs	yes	no	yes	no	HUN	calculus	nil	gener	2	YES	1		BIL CAL	NO	2			
HN	35	4	nil	pcnl	no	yes	no	no	normal	normal	nil	gener							2	3	1	3
caliectasis	22	5	nil	pcnl	no	yes	no	no	lc calculus	normal	nil	AD							2	3	1	3
normal	19	5	nil	pcnl	no	no	no	no	normal	normal	pcnl urs	gener							2	3	1	3
PUJ strict	44	4	nil	pcnl	no	yes	no	no	normal	normal	urs	gener							2	2,3	2	2,3
bifid opp pelvis	7	1	nil	urs	yes	no	yes	no	uc calculs	normal	nil	gener	2	YES	1	2	UU AND OPP RENAL CAL	OBSTRUCTED SYSTEM	2			
normal	7	4	nil	urs	yes	no	yes	no	normal	normal	nil	gener	2	YES	1	2	UU CAL	OBSTRUCTED SYSTEM				
caliectasis	24	4	nil	pcnl	no	yes	no	no	normal	normal	nil								2	3	1	3
bifid pelvis	22	4	nil	pcnl		yes		no	normal	uu calcu	swl op k	gener							2	3	1	3
normal	14	3	fillin dfect	urs	yes	no	yes	dm	normal	normal	pcnl	gener	1	YES	1	1	LU CAL	NO	2			
caliectasis	21	5	nil	pcnl	no	no	no	nil	normal	normal	nil	gener							2	3	1	3
normal	8	1	nil	urs	yes	no	yes	dm htn	normal	normal	nil	AJPG	2	NO	2		LU CAL	NO				
rim nephogram	34	5	nil	pcnl	no	yes	yes	no	normal	normal	nil	SKS					PEL CAL		2	3	1	3
calyceal diver	26	4	infund sten	pcnl	no	no	no	no	normal	normal	pyl	NK							2	3	1	3
parenchy calc	27	4	puj narr	pcnl	no	yes	no	no	par cal	normal	nil	gener							2	3	1	3
HN	15	4	fillin dfect	pcnl	no	yes	no	no	cyst	normal	nil								1	3	1	3
delay drainage	41	5	nil	pcnl	no	yes	no	hemo p	normal	normal	r pcnl	RPM							1	3	1	3
delay drainage	7	1	nil	urs	yes	no	yes	htn	normal	normal	nil	NTJ	2	NO	2		LU CAL	NO	2			
normal	10	1	nil	urs	yes	no	yes	no	normal	normal	urs l	rajadoss	2	NO	1		UU	NO	2			
normal	55	5	nil	pcnl	no	yes	no	htn	NFK	normal	nephrect	gener							2	1,2	2	1,2
HN	38	4	tor ureter	pcnl	no	yes	no	htn ihd	caliectasis	normal	opp pyl								2	3	1	3
bifid pelvis	34	4	nil	pcnl	no	yes	no	dm htn	normal	normal	nil	anuj							2	3	1	3
opp stag horn	25	4	nil	pcnl	no	yes	no	HTN	staghorn	normal	pyl	NA							2	3	1	3
normal	8	1	nil	urs	yes	no	yes	dys urice	normal	normal	nil	AD	1	YES	1	4	LU CAL	NO	2			
stand colum	17	2	nil	urs	yes	no	yes	no	normal	normal	nil	AJPG	2	YES	1	2	MULTIPLE LU CAL	OBSTRUCTED SYSTEM	2			
dense nehrogram	51	5	nil	pcnl	no	yes	no	no	cyst	normal	nil	RPM							2	3	1	3
hun	32	4	nil	pcnl	yes	no	yes	HTN	calculus	normal	nil	SKS							2	2	1	2
normal	26	4	fillin dfect	pcnl	no	yes	no	no	calculus	normal	nil	anuj							2	3	1	3
normal	13	1	nil	urs	no	no	no	no	normal	normal	nil	anuj	2	NO	1		LU CAL WITH OPP REANL	NO	2			
narrow infudi	15	4	nil	miniperc	no	no	no	no	absent	absent	swl	SKS							2	3	1	3
delay drainage	52	4	nil	pcnl	no	yes	no	HTN	normal	normal	nil	SKS							1	3	1	3
delay drainage	35	4	fillin dfect	pcnl	no	yes	no	no	normal	normal	nil	SKS							1	2	1	2
parenchy scarr	53	5	nil	pcnl	no	yes	no	HTN	lc calculus	normal	swl	RPM							2	3	1	3
renal calulus	11	1	nil	urs	no	no	no	hypothy	lc calculus	normal	nil	anuj	2	NO	2		RIGHT URETER RENAL	NO	2			
PUJ strict	22	4	fillin dfect	pcnl	no	yes	no	no	normal	normal	nil	AD							2	3	1	3
delay drainage	44	4	nil	pcnl	no	yes	no	no	caly diver	normal	nil	gener							2	2,3	2	3
stand colum	12	1	fillin dfect	urs	yes	no	yes	dm	lc calculus	normal	nil	gener	2	YES	2		MID URETERIC CAL	OBSTRUCTED SYSTEM	2			

AJPG	NA							laxmikant	000867g	58	left	mu	11	1	25	22	17	hun	norm	mu	1.3		no	yes	prompt
NA	AJPG							anwarol	788961f	71	left	pel uc	11	2	14	17	11	hn	norm	pel uc	0.8		no	no	prompt
NA	AJPG							anand	599300c	39	left	lu	10	1	24	21	16	no	norm	lu	0.8		no	no	prompt
AJPG	NA							shanthi	208593b	47	left	lc	9	1	23	20	21	no	norm	lc	0.6		no	no	prompt
NA	AJPG							yassar	077681d	24	left	uu	11	1	22	21	16	no	norm	uu	1		no	no	prompt
AJPG	NA							kumari	580653d	62	right	lc mc	11	4	16	10	13	no	norm	lc mc	0.7		no	no	prompt
NA	AJPG							pradip	760201f	46	left	lc lu	12	2	22	17	10	hun	norm	lc lu	0.7		no	yes	prompt
NA	CS	R1	R PCNL	No	No	RGU dem incomp dup		sanjay	762863f	42	right	pel mc lc	8	3	21	14	14	no	norm	pel mc lc	0.8		no	no	prompt
AJPG	NA							fanibushan	765226f	51	right	all cal	12	4	10	14	19	no	norm	all cal	0.7		no	no	prompt
CS	AJPG	L1	L URS	No	No			rani	765914f	71	left	mu	9	1	21	15	18	hun	norm	mu	0.6		no	yes	prompt
CS	AJPG	L1	L PCNL	No	No			shamshad	796430f	54	left	pel uu	11	1	23	21	11	hn	norm	pel uu	1.3		yes	no	prompt
CS	AJPG	R1	R PCNL	No	No			Wanshan	811218F	48	right	pel all cal	9	5	19	15	19	hn	norm	pel all ca	1		yes	no	prompt
CS	AJPG	L1	L PCNL	No	No			gour	833372F	29	left	pel	10	1	15	11	13	no	norm	pel	0.8		no	no	prompt
CS	AJPG	R1	R PCNL	Not avl	No			prabhash	836676f	53	right	pel	11	1	22	18	23	hn	norm	pel	0.9		yes	789702D	prompt
								Santi ranj	112599g	59	left	lu	11	1	17	16	13	no	norm	lu	0.8		no	no	prompt
CS	NA	R1	R PCNL	No	No			kalawati	430164F	50	right	pel	9	1	18	11	15	hn	norm	pel	0.6		yes	no	prompt
CS	NA	R1	R PCNL	No	No			swapan	753251c	41	left	pel lu	12	3	15	18	15	no	norm	pel lu	0.8		yes	no	prompt
CS	NA	L1	L PCNL	No	No			santosh	793798f	44	left	pel mc lc	12	4	28	21	11	no	norm	pel mc lc	0.8		no	no	prompt
CS	NA	R1	R URS	No	No			bandalarin	829857f	62	right	lu	10	1	23	22	14	hun	norm	lu	0.6		no	yes	prompt
CS	NA	L1R1	B/L URS	No	No			chidaramna	808581f	55	right	uu	11	1	27	21	25	hn	norm	uu	1.1		yes	no	prompt
plan aft	plan aft	Assessmen	Procedure pla	Any change	Any change in plan after IVU			Name	hospital nu	age	SIDE	SITE	13	NUMBER	UP	MP	LP	HUN	ECHO	CALYX	CREAT	ivu	HN	HUN	drain
								farida	000836g	50	right	pel mc lc	11	4	15	10	9	hn	norm	pel mc lc	0.5		yes	no	delayed
								atul	034566g	53	left	pel lc	10	2	27	20	31	hn	norm	pel lc	0.8		yes	no	prompt
								sampa	030207G	29	left	pel	9	1	20	14	13	no	norm	pel	0.7		no	no	prompt
								punam	027688g	27	right	lu	8	1	14	11	15	hun	norm	lu	0.5		no	yes	prompt
								suhriti	028285D	51	left	lc	10	1	16	16	14	no	norm	lc	0.5		no	no	prompt
								sankar	072879g	48	left	pel lc	9	3	16	10	10	no	norm	pel lc	0.9		yes	no	prompt
								narayanan	018194G	44	left	lu	11	1	16	17	14	no	norm	lu	0.8		no	yes	delayed
								Ethiraj	196811c	66	right	uu	9	1	14	15	12	no	incres	uu	1.5		yes	opp	prompt
								mohsin	015736G	59	left	pel	12	2	13	14	13	hn	norm	pel	0.9		yes	no	delayed
								nurul	046396G	45	right	uu	11	1	22	22	23	hun	norm	uu	1		op kidney	yes	prompt
								abubaker a	091673G	20	left	uu	10	1	24	20	25	hun	norm	uu	1.3		no	yes	prompt
								nurul kader	043195g	28	left	pel	12	2	18	22	20	no	norm	pel	0.9		no	no	prompt
								suresh das	097186g	34	right	pel lc	11	2	13	17	12	hn	norm	pel lc	0.8		yes	no	prompt
								Manoj	089907g	37	right	pel uc	10	1	19	14	17	hn	norm	pel uc	0.7		yes	no	delayed
								Uttam R	854219c	39	right	pel uu	14	2	10	17	19	hn	norm	pel uu	0.7		yes	no	prompt
								Bishu	230697F	37	right	pel lc	11	2	23	16	18	hn	norm	pel lc	1.1		yes	no	prompt
								Binod	052404G	37	left	pel mc lc	11	3	6	10	5	hun	norm	pel mc lc	0.8		yes	yes	prompt
								Murali	869528F	38	right	pel lc	10	1	26	24	16	no	norm	pel lc	0.8		yes	no	prompt
								Priya	035370G	50	left	mu	10	1	28	20	16	hun	norm	mu	1.3		no	yes	prompt
								manoranjan	032301G	64	left	pel uc mc	11	1	16	13	17	hn	norm	pel uc mc	1.18		yes	no	delayed
								meenakshi	099801G	35	right	mc	10	2	16	15	16	no	norm	mc uu	0.5		no	no	prompt
								siddartha	102008g	30	left	lu	10	1	23	20	14	hun	norm	lu	0.9		no	yes	prompt
								Bebi	048500G	39	right	pel lu	9	2	24	26	28	hn	norm	pel lu	0.8		yes	yes	prompt
								Badsa	849298F	34	right	lu mu	11	2	30	18	20	hun	norm	lu mu	1.1		no	yes	prompt
								sasi	915489F	37	right	uu	10	1	20	21	24	hun	norm	uu	1.2		no	yes	prompt
								Mukesh	049507G	28	right	lu	11	1	31	28	27	hun	norm	lu	0.9		no	yes	prompt
								sandya	177302D	56	right	pel	9	17	21	12	18	hun	norm	pel mc lc	0.66		no	yes	delayed
								Birendra	241445b	49	left	pel all cal	11	1	14	11	17	hn	norm	pel all ca	1.3		yes	no	prompt
								Rina	070072G	43	right	mu	9	1	19	16	22	no	norm	mu	0.9		no	no	prompt
								Prabir	062364G	32	left	pel mc lc	12	1	22	20	22	hn	norm	pel mc lc	0.9		yes	no	delayed
								archana	072819G	52	left	mu	11	1	17	11	20	hun	norm	mu	0.7		no	yes	prompt
								pratima	062388G	26	left	lu	10	1	22	17	20	hun	norm	lu	0.5		no	yes	prompt
								Nadup	059308G	37	left	lc	11	1	13	16	18	no	norm	lc	0.6		no	no	prompt
								Parbeen	824380f	33	left	lc	11	1	17	16	11	hn	norm	lc	0.8		yes	no	prompt
								Tania	062435g	52	left	lu	9	1	13	14	14	hun	norm	lu	1.06		no	yes	prompt
								Bishal	612246f	29	right	mu	11	1	14	17	21	hun	norm	mu	0.9		no	yes	prompt
								Bhupen	054591g	42	left	lu	9	1	17	20	13	no	norm	lu	0.8		no	yes	prompt
								Debrata	609383F	33	right	lc	9	2	15	15	16	no	norm	lc	1		yes	no	prompt
								dhinu	097257g	47	right	lu	9	1	14	15	18	no	norm	lu	0.9		no	no	prompt
								arun	114632g	38	left	uu	9	2	17	11	14	hun	norm	uu	0.8		no	yes	prompt
								abhinash	103736g	33	right	lu	12	1	22	18	19	hun	norm	lu	0.7		no	yes	prompt
								pranab	078607G	35	right	uu lc	10	2	18	17	22	hun	norm	uu lc	1		no	no	prompt
								abu taleb	079129G	34	left	pel mc	11	1	20	20	21	hn	norm	pel mc	0.6		yes	no	prompt
								Hemant	088141g	31	left	mu	10	1	19	17	17	hun	norm	mu	1		no	yes	prompt
								Sanjay	089424g	44	right	pel lc	11	1	16	19	14	hn	norm	pel lc	0.7		yes	no	prompt
								Hashim	078654G	19	left	uu	10	1	15	22	13	hn	norm	puj	1		yes	no	prompt
								Madhab	018799g	32	left	mc lc	10	2	18	20	17	hn	norm	mc lc	1		yes	no	prompt
								sitaram	082082G	42	right	mc lc	10	3	17	23	15	hn	norm	lc	0.7		yes	no	prompt
								subir	093247G	39	left	lu	7	1	11	10	9	no	small l kid	lu	1.3		no	no	prompt
								rahaman	133411g	49	left	pel all cal	10	1	22	14	15	hn	norm	pel all ca	1.1		yes	no	prompt
								Rabin	130789g	43	right	pel uc lc	11	3	17	17	17	hn	small r kid	pel uc lc	1.1		yes	no	prompt
								Ackshed	131114g	35	right	uu	11	1	22	16	22	hun	norm	uu	1.3		no	yes	delayed
								Shiva pra	103307G	44	right	lc	10	1	17	12	17	hn	norm	lc	0.8		yes	no	prompt
								golden	122069g	11	right	uu	8	1	11	11	10	hun	incres	uu	1.2		no	hun	prompt
								Bipul	116074g	36	right	mc	10	1	16	13	22	hn	norm	mc	0.8		hn	no	prompt

delay drainage	10	1	fillin dfect	urs	yes	no	yes	dm	normal	normal	nil	CS	2	YES	1		MID URETERIC CAL	OBSTRUCTED SYSTEM	2				
caliectasis	31	5	nil	pcnl	no	no	no	no	staghorn	normal	nil	RPM							1	3 x2	2	3 x2	
normal	6	1	nil	urs	no	no	no	dm	normal	normal	nil	NTJ	2	NO	2		VUJ CAL	NO	2				
normal	23	4	nil	pcnl	no	no	no	no	lc calculus	normal	nil	gener							1	3	1	3	
caliectasis	19	4	fillin dfect	pcnl	yes	no	yes	no	normal	normal	nil	gener							2	3	1	3	
caliectasis	28	4	nil	pcnl	no	no	no	dm htn	lc calculus	normal	nil	gener							2	3	1	3	
lower pole scarr	25	4	fillin dfect	pcnl urs	no	yes	no	HTN	normal	normal	nil	sagar							2	3	1	3	
caliectasis	40	4	nil	pcnl	no	no	no	no	normal	normal	nil	AJPG							2	3	1	3	
delay drainage	38	5	nil	pcnl	no	no	no	no	lc cyst	normal	nil	CS							1	1	1	1	re procedu
normal	10	1	fillin dfect	urs	yes	no	yes	no	normal	normal	nil	gener	2	NO	1	4	MU CAL	NO	2				
PUJ scarr	19	4	nil	pcnl	no	yes	no	no	normal	normal	nil	AP							1	3	1	3	
PUJ narr	50	4	nil	pcnl	no	yes	no	HTN	normal	normal	nil	gener							1	1,3	2	3	
extra renal pelvis	30	4	nil	pcnl	no	no	no	no	normal	normal	nil	gener							2	3	1	3	
delay drainage	23	4	nil	pcnl	no	yes	no	htn	normal	normal	nil	gener							1	3	1	3	
filling defct	7	1	nil	urs	no	no	no	no	normal	normal	nil		2	NO	1	4	LU CAL	NO	2				
normal	23	4	nil	pcnl	no	yes	no	no	normal	normal	ss pyl	anuj							1	3	1	3	
delay drainage	34	4	fillin dfect	pcnl	no	yes	no	dm	normal	normal	nil	RPM							2	3	1	3	
gross caliectasis	39	5	no	pcnl	no	yes	no	no	normal	normal	nil	RPM							1	3	1	3	
normal	11	1	no	urs	no	no	no	lmn palsy	normal	normal	nil	NK	2	NO	2		LU CAL	NO	2				
normal	10	1	no	urs	no	yes	no	no	hn	uu calcu	nil	NTJ	1	YES	1	1	BIL URETERIC CAL	NO	1				
pcs	size	RGU	other	Procedure	HUN	HN	HUN	comorb	opp kidney	OPP URETER	previo	P cons	IMPACT	IVU FW	STENT	REASON	KUB USG	ADDITIONAL INFO	STONE CLEARANCE	PUNCTURE	NO OF PUNCTURES	DILATED	
caliectasis	34	4	fillin dfect	pcnl	no	yes	no	psoariasi	normal	normal	nil								1	1	1	1	
normal	40	4	fillin dfect	pcnl	no	yes	no	dm htn	normal	normal	opp urs								2	3	1	3	
normal	16	4	fillin dfect	pcnl	no	no	no	no	IP calculus	normal	nil								2	2	1	2	
blunting of calyces	11	1	fillin dfect	urs	yes	no	yes	no	normal	normal	nil		2		1	3		YES	2				
caliectasis	13	4	fillin dfect	pcnl	no	no	no	dm	normal	normal	nil								2	3	1	3	
blunting of calyces	40	4	fillin dfect	pcnl	no	yes	no	no	mc cyst	normal	opp pyl								2	3	1	3	
normal	11	1	fillin dfect	urs	yes	no	yes	no	normal	UU narr	nil		2		1	2		NO	2				
delay drainage	18	1	fillin dfect	urs	yes	no	yes	dm	staghorn	normal	nil		2		1	4			2				
puj narr	40	5	fillin dfect	pcnl	no	yes	no	no	cyst	normal	nil								2	3	1	3	
opp hn	11	1	fillin dfect	urs	yes	no	yes	dm htn	opp hn	normal	nil		2		1	4			1				
blunting of calyces	15	4	fillin dfect	pcnl	yes	no	yes	no	normal	normal	nil								2	2	1	2	
hn	20	4	fillin dfect	pcnl	no	yes	no	no	normal	normal	nil							NO	2	3	1	3	
blunting of calyces	38	4	fillin defct	pcnl	no	yes	no	no	calulus	normal	nil								1	3	1	3	
hn	15	4	fillin defct	pcnl	no	yes	no	no	normal	normal	nil								2	1	1	1	
hn	20	5	fillin defct	pcnl	no	yes	no	no	normal	normal	ss urs								2	3	1	3	
hn	22	4	fillin defct	pcnl	no	yes	no	htn	normal	normal	nil								2	3	1	3	
narr dis ureter	28	5	fillin defct	pcnl	no	yes	no	tubercul	normal	normal	nil								2	3	1	3	
hn	30	4	fillin defct	pcnl	no	yess	no	dm	lc calculus	normal	nil								2	3	1	3	
hun	7	1	fillin defct	urs	yes	no	yes	no	mc cal	uu calcu	opp pyl		1		1	1		NO	2				
blunting of calyces	58	4	fillin defct	pcnl	no	yes	no	dm htn	normal	normal	nil								1	3X2	2	3X2	
stand column	9	1	normal	urs	no	no	no	no	normal	normal	nil		2		2		UU and renal cal	NO	2				
hun	9	1	fillin defct	urs	yes	no	yes	no	normal	normal	swl		2		2		Ureteric only	no	2				
caliectasis	21	2	hun	rirs urs	yes	no	yes	no	normal	normal	nil		2		1	4	Renal and ureteric	NO	1				
hun	10	1	sticture	urs	yes	no	yes	dm htn	normal	normal	nil		2		1	5	Urteric and renal	NO	2				
stand column	10	3	fillin defct	urs	yes	no	yes	no	lc calculus	normal	nil		1		1	1	Urteric and renal		1				
stand coumn	8	3	fillin defct	urs	yes	no	yes	no	normal	normal	nil		1		1	1	Ureteric only	NO	2				
hun	24	4	stricture uu	pcnl	yes	no	yes	no	normal	normal	ss pyl								2	3	1	3	
hn	25	5	fillin defct	pcnl	no	yes	no	no	staghorn	normal	nil								1	3	1	3	
stand column	12	1	fillin defct	urs	no	no	no	no	calculus	normal	nil		2		2		Ureteric only	NO	2				
caliectasis	44	4	fillin defct	pcnl	no	yes	no	no	cyst	lu calculus	nil								2	3	1	3	
hun	8	1	fillin defct	urs	yes	no	yes	no	normal	focal kink	nil		2		2		Ureteric only		2				
hun	8	1	fillin defct	urs	yes	no	yes	no	normal	normal	nil		2		1	2			2				
blunting of calyces	18	4	fillin defct	pcnl	no	no	no	dm	normal	normal	nil								2	2	1	2	
caliectasis	24	4	fillin defct	pcnl	no	yes	no	no	normal	normal	nil								2	3	1	3	
bifid pelvis	8	1	fillin defct	urs	yes	no	yes	hypothy	normal	normal	nil		2		1	2	Ureteric only		2				
hun	12	1	fillin defct	urs	yes	no	yes	no	normal	normal	nil		2		1	4	Ureteric only	NO	1				
hun	10	1	fillin defct	urs	yes	no	yes	no	normal	normal	nil		2		1	4	Ureteric only	NO	1				
caliectasis	18	4	fillin defct	pcnl	no	yes	no	dm htn	normal	normal	nil								2	3	1	3	
normal	7	1	fillin defct	urs	no	no	no	no	calculus	normal	nil		2		2		Ureteric only	NO	2				
fullness of pcs	9	1	fillin defct	urs	yes	no	yes	no	normal	normal	nil		2		1	4	Ureteric only	NO	2				
normal	11	1	tor ureter	urs	yes	no	yes	no	normal	normal	nil		2		2		Ureteric only	NO	2				
bifid renal pelvis	22	4	fillin defct	pcnl urs	no	no	no	no	normal	lu calculus	nil		2		1	4	Renal and urteric	NO	2				
caliectasis	24	4	fillin defct	pcnl	no	yes	no	no	normal	normal	ss pyl								2	2 x2	2	2x2	
hun	13	1	fillin defct	urs	yes	no	yes	no	normal	mu calculus	nil		2		1	4	Ureteric only	NO	2				
hn	24	4	fillin defct	pcnl	no	yes	no	dm	normal	normal	ss pyl								1	3 x2	1	3x1	
balloning of calyces	15	1	fillin defct	urs	no	yes	no	no	normal	normal	nil		2		1	5	Ureteric only	NO	1				
caliectasis	17	4	fillin defct	pcnl	no	yes	no	no	normal	normal	nil								2	3	1	3	
blunting of calyces	24	4	bifid pelvis	pcnl	no	yes	no	no	normal	normal	nil								1	3	1	3	re procedu
normal	8	1	fillin defct	urs	no	no	no	no	normal	normal	nil		2		1	2	Ureteric only		1				
caliectasis	54	4	fillin defct	pcnl	no	yes	no	dm htn	normal	normal	nil								2	1,2	2	1,2	
puj narr	38	4	fillin defct	pcnl	no	yes	no	htn	calulus	normal	ss pcnl								2	3	1	3	
dense nehrogram	12	1	fillin defct	urs	yes	no	yes	no	normal	normal	nil		2		2		Ureteric only		2				
caliectasis	23	4	fillin defct	pcnl	no	yes	no	no	normal	normal	nil								2	2	1	2	
extra renal pelvis	12	2	medull cal	urs	yes	no	yes	hyperpa	calulus	lu calculus	nil		2		1	2	Ureteric only	NO	2				
caliectasis	14	4	fillin defct	pcnl	no	yes	no	no	normal	normal	nil								1	3	1	3	